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THE WILLAMETTE BASIN COMPREHENSIVE STUDY OF WATER AND RELATED L--ETC(U)
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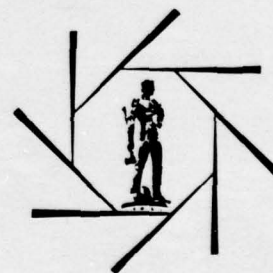
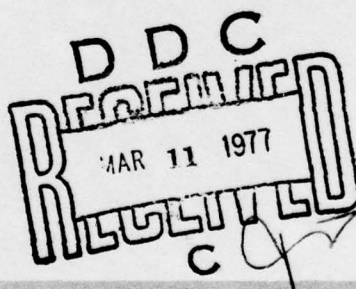


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WILLAMETTE BASIN
COMPREHENSIVE STUDY
Water and Related Land Resources



MAIN REPORT

WILLAMETTE BASIN TASK FORCE - PACIFIC NORTHWEST RIVER BASINS COMMISSION

1969

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The WILLAMETTE BASIN

COMPREHENSIVE STUDY of

Water and
Related Land
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Main Report.



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MAIN REPORT

WILLAMETTE BASIN TASK FORCE - PACIFIC NORTHWEST RIVER BASINS COMMISSION

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ORGANIZATION

PACIFIC NORTHWEST RIVER BASINS COMMISSION

Columbia Basin Inter-Agency Committee until 1967

WILLAMETTE BASIN TASK FORCE

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Commerce

Army

Labor

Agriculture

Federal Power Commission

Interior

Health, Education and Welfare

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**PLAN
FORMULATOR**

APPENDIX COMMITTEES

A. Study Area

G. Land Measures and Watershed Protection

B. Hydrology

H. Municipal and Industrial Water Supply

C. Economic Base

I. Navigation

D. Fish and Wildlife

J. Power

E. Flood Control

K. Recreation

F. Irrigation

L. Water Pollution Control

M. Plan Formulation

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The Willamette Basin Comprehensive Study has been directed and coordinated by the Willamette Basin Task Force listed above. The Task Force has been assisted by a technical staff, a plan formulator and a report writer.

BASIN DESCRIPTION

Between the crests of the Cascade and Coast Ranges in northwestern Oregon lies an area of 12,045 square miles drained by Willamette and Sandy Rivers--the Willamette Basin. Both Willamette and Sandy Rivers are part of the Columbia River system, each lying south of lower Columbia River.

With a 1965 population of 1.34 million, the basin accounted for 68 percent of the population of the State of Oregon. The State's largest cities, Portland, Salem, and Eugene, are within the basin boundaries. Forty-one percent of Oregon's population is concentrated in the lower basin subarea, which includes the Portland metropolitan area.

The basin is roughly rectangular, with a north-south dimension of about 150 miles and an average width of 75 miles. It is bounded on the east by the Cascade Range, on the south by the Calapooya Mountains, and on the west by the Coast Range. Columbia River, from Bonneville Dam to St. Helens, forms a northern boundary. Elevations range from less than 10 feet (mean sea level) along the Columbia, to 450 feet on the valley floor at Eugene, and over 10,000 feet in the Cascade Range. The Coast Range attains elevations of slightly over 4,000 feet.

The Willamette Valley floor, about 30 miles wide, is approximately 3,500 square miles in extent and lies below an elevation of 500 feet. It is nearly level in many places, gently rolling in others, and broken by several groups of hills and scattered buttes.

Willamette River forms at the confluence of its Coast and Middle Forks near Springfield. It has a total length of approximately 187 miles, and in its upper 133 miles flows northward in a braided, meandering channel. Through most of the remaining 54 miles, it flows between higher and more well defined banks unhindered by falls or rapids, except for Willamette Falls at Oregon City. The stretch below the falls is subject to ocean tidal effects which are transmitted through Columbia River.

Most of the major tributaries of Willamette River rise in the Cascade Range at elevations of 6,000 feet or higher and enter the main stream from the east. Coast Fork Willamette River rises in the Calapooya Mountains, and numerous smaller tributaries rising in the Coast Range enter the main stream from the west.

In this study, the basin is divided into three major sections, referred to as the Upper, Middle, and Lower Subareas (see map opposite). The Upper Subarea is bounded on the south by the Calapooya Mountains and on the north by the divide between the McKenzie River drainage and the Calapooya and Santiam drainages east of the valley floor and by the Long Tom-Marys River divide west of it. The Middle Subarea includes all lands which drain into Willamette River between the mouth of Long Tom River and Fish Eddy, a point three miles below the mouth of Molalla River. The Lower Subarea includes all lands which drain either into Willamette River from Fish Eddy to its mouth or directly into Columbia River between Bonneville and St. Helens; Sandy River is the only major basin stream which does not drain directly into the Willamette.

For detailed study, the three subareas are further divided into 11 subbasins as shown on the map.

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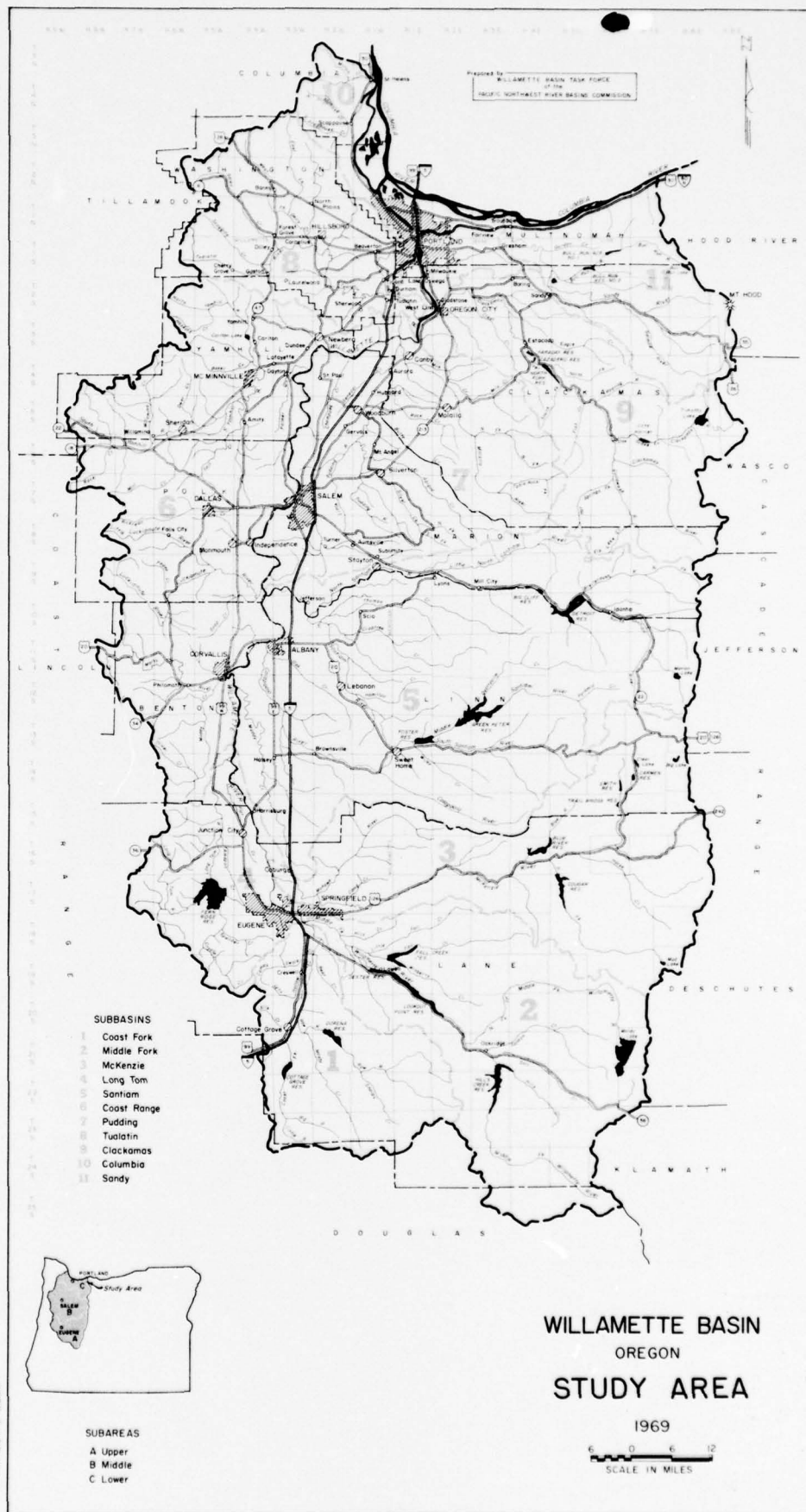


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THEME STATEMENT

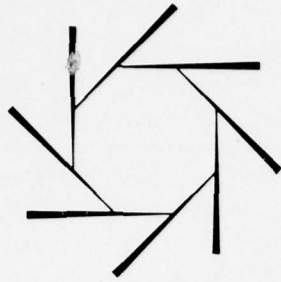
We as Willamette residents are entering an era of unprecedented growth and development, which threatens, and if allowed to proceed without plan will destroy, much of our environmental heritage.

Neither the armor of total preservation of what we now have nor the faith of resignation to progress is adequate response to this threat. Changes will come; changes that will alter the face of the land. If we are to step into the future without leaving behind the type of life we value so highly, we must plan each phase of our development, keeping in mind that beyond the economic necessities livability is the number-one priority.

To the extent that our various planning efforts are directed toward maintaining and enhancing our total livability, we will be responsive to one of the major tasks history has assigned our generation.

We must seek, at every level, the courses of action which will insure for future generations a quality life in an environment in which each individual can find opportunity, dignity, and a sense of purpose.





S U M M A R Y

Population estimates indicate that by 2020 Willamette Basin's population will more than triple; thus, the need for water control and for water and related land resource development will greatly increase.

Although much has been done, serious problems of control and conservation of water remain unsolved. Several major existing projects and project authorizations do not include specific provisions for the potential new primary project functions of fish and wildlife enhancement, water supply, water quality control, and recreation.

Serious flooding on the larger streams and main stem has occurred as recently as 1964, while many smaller streams flood annually. There is substantial interest in additional irrigation development. There are a number of areas requiring drainage and erosion control. A need and an opportunity exist for enhancement of the extensive anadromous fish resource. Future municipal and industrial water supply needs will require additional storage. Serious water pollution problems exist and will continue even with high levels of treatment at the waste sources; thus, additional streamflow will be required for water quality control. The growing population will create an increased demand for recreational facilities. Present in-basin power development does not meet basin needs; however, power supply is based on optimum use of regional power resources whether within or

outside the basin.* Also, there may be a need for increased navigation development on Willamette River. In summary, the rapidly expanding population will bring the full range of water and related land resource problems and needs in increasing intensity.

Planning for major water resource development has been underway in Willamette Basin for more than 40 years. In the early 1960's the various Federal agencies concerned with water and related lands were directed to prepare a comprehensive development and preservation plan for the basin. The plan which was developed in response to the directive, detailed in Appendix M - Plan Formulation and supported by the various functional appendixes, is summarized in this report.

The plan consists of a number of elements, which can be grouped into three categories: those projects and programs which exist or are assured; those early-action projects and programs which are needed to meet needs that exist or will develop in the next 10-15 years; and, finally, those long-range projects and programs which would meet needs that will develop between 1980 and 2020.

The early-action elements of the plan include construction of 15 new major storage reservoirs, modification of one existing reservoir, and enlargement of one authorized reservoir. New storage capacity

obtained in those major projects would total 1,349,000 acre-feet. Those projects are:

(1) Jordan Dam and Reservoir--The reservoir on Thomas Creek in Linn County would have a capacity of about 93,000 acre-feet. Project purposes include flood control, irrigation, water supply, navigation, water quality, fish and wildlife, and recreation.

(2) Lyons Dam and Reservoir--Storage capacity would be about 110,000 acre-feet for purposes of flood control, water supply, and increased downstream flow for navigation, fish life and recreation. The project would be located on Little North Santiam River.

(3) Gorge Dam and Reservoir--The reservoir, on Mill Creek, a tributary of South Yamhill River, would store about 53,000 acre-feet for irrigation, flood control, recreation, fish and wildlife.

(4) Noon Dam and Reservoir--The project on Marys River near the town of Wren would store about 115,000 acre-feet for flood control, irrigation, M&I water supply, and increased downstream flows for navigation and water quality improvement for recreation and fish life.

(5) Pedee Dam and Reservoir--The reservoir on Luckiamute River would store about 130,000 acre-feet. Project functions would include flood control, irrigation, M&I water supply, and additional downstream flows for navigation and improved water quality for fish life and recreation.

(6) Moore's Valley Dam and Reservoir and (7) Pike Dam and Reservoir--These two reservoirs are included in the plan as a part of the Carlton Division multiple-purpose project to serve the functions of flood control, irrigation, recreation, and fish and wildlife. Moore's Valley site is on Haskins Creek, and the Pike site is on North Yamhill River. Total storage at the two sites would be 105,000 acre-feet.

(8) Agency Dam and Reservoir, (9) Buck Hollow Dam and Reservoir, and (10) Gopher Valley Dam and Reservoir--These three reservoirs, on South Yamhill River, Willamina Creek, and Deer Creek, respectively, would store a total of 195,000 acre-feet for flood control, irrigation, recreation, and fish and wildlife.

(11) Dickey Bridge Dam and Reservoir, (12) Grange Dam and Reservoir, and (13) Selah Dam and Reservoir--These three reservoirs, on Molalla River, Silver Creek, and Pudding River, respectively, would store about 375,000 acre-feet of water for flood control, irrigation, recreation, and fish and wildlife.

(14) Gaston Dam and Reservoir and (15) East Fork Dairy Creek Dam and Reservoir--These two reservoirs on Tualatin River and East Fork Dairy Creek, respectively, would be a part of the Tualatin Project, second phase. Total storage capacity would be 115,000 acre-feet for flood control, irrigation, M&I water supply, recreation, fish and wildlife and water quality control.

(16) Dorena Modification--The plan calls for modification of the existing Dorena Dam on Row River to provide for an additional 10,000 acre-feet of flood control storage space.

(17) Holley Dam and Reservoir--This is a proposed reauthorization, to provide for increased capacity and additional uses, of a project previously authorized but not funded for construction. The enlarged project on Calapooia River would have a 145,000-acre-foot capacity, an increase of 48,000 over the authorized capacity of 97,000. It would be used for flood control, irrigation, fish and wildlife enhancement, recreation, water supply, water quality control, and navigation.

In addition to major storage reservoirs, the plan includes 26 watershed projects, many of which include land treatment as

well as structural works such as channel improvements for flood control and drainage, and irrigation facilities. The 39 smaller storage reservoirs in those projects would provide a total storage capacity of 325,000 acre-feet; 54,000 acre-feet of that total are in reservoirs which are possible alternatives to two major reservoirs discussed above. The watershed projects included in the plan are:

Camas Swale Cr.	Palmer Cr.
Cloverdale Area	Salt Cr.
Rattlesnake Cr.	Ash Cr.
Ferguson Cr.	L. Luckiamute R.
Bear Cr.	Soap Cr.
Coyote-Spencer Cr.	W. Muddy Cr.
San Thomas	Butte Cr.
Grand Prairie	Drift-Pudding Cr.
E. Muddy Cr.	Mill Cr.
Walton Slough	E. Dairy Cr.
Chehalem	W. Dairy Cr.
Spring Valley	Fairview Cr.
Deer Cr.	Johnson Cr.

Another major element in the early-action plan is an enlarged navigation channel from Willamette Falls to the Albany-Corvallis area. The enlargement would be done in conjunction with the authorized reconstruction of Willamette Falls Lock and provision of additional low-water flows from planned upstream storage.

Other structural elements in the early-action plan include several channel improvement projects and two irrigation projects—Monmouth-Dallas and Calapooia.

The early-action plan also includes a variety of programs which are needed to meet needs in the functional fields of flood control, irrigation, navigation, water quality control, recreation, fish life and wild-

life. A particularly significant program, in terms of the basin ecology and overall quality of life, is for free flowing river management. The plan includes a recommendation that more than 1,250 miles of streams be managed for protection of desirable natural environments.

The long-range plan includes many elements to satisfy the additional needs created by continued population growth. Principal elements of the long-range plan include 37 reservoirs aggregating about 887,000 acre-feet of storage capacity, pumped-storage facilities for peaking power aggregating 23,000 megawatts of power-generating capacity, and programs for water pollution control, fish and wildlife, recreation, and irrigation.

Implementation of all plan elements, including existing, authorized, and assured elements, would provide a high degree of service to 2020 needs in each of the functional fields. Included would be more than 3.3 million acre-feet of flood-control storage; irrigation of 1 million acres; annual production of 26 million anadromous fish and 7 million resident fish; 1.6 million acre-feet of municipal and industrial water; water-based recreation facility capacity of 71 million recreation-days; peaking power capacity of 92,000 megawatts, and a flow of 7,500 cfs in Portland Harbor for water quality control.

The comprehensive plan would involve a total investment by 2020 of \$5.7 billion in projects and permanent improvements. Those projects that exist or are authorized or assured have a cost of about \$630 million; thus the new elements of the comprehensive plan would cost about \$5.1 billion. The early-action part of the plan would cost \$970 million.

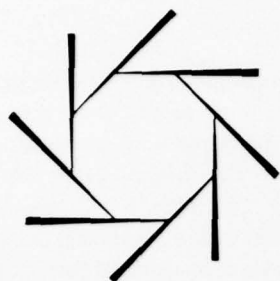
Plan Element	Future Development Costs, \$1,000,000		
	Early-action	Long-range	Totals
Programs	276	827	1,103
Reservoirs	352	186	538
Nonstorage projects	343	220	563
Power projects	---	2,854	2,854
Total	971	4,087	5,058

Solving the dilemma between man's needs and his wants is no simple task, but it is one we, as a people, will continue to attempt to resolve as we face each new day.

Congressman Wayne N. Aspinall

1841 - First Methodist mission in Willamette Basin on the far side of Willamette River.





INTRODUCTION

THE PAST

The first permanent non-Indian residents in Willamette Valley were fur traders who began to settle in 1812. "A dwelling and trading house" was built late in 1812 or early in 1813 about on the site of the present City of Salem by two clerks associated with the John Jacob Astor enterprise. Also, Joseph Gervais and Etienne Lucier, formerly Astorians, are said to have had a camp, with their families, on Pudding River near its confluence with the Willamette. By 1831, there were three farms in the valley south of Willamette Falls.

The Oregon Historical Society provides the following description of the motivation for early settlement:

"The reports of fur traders like Jedediah Smith, B. L. E. Bonneville, and Nathaniel Wyeth, the dreams of Hall Jackson Kelley, and the letters and tours of missionaries like Jason Lee and Marcus Whitman, both of whom returned East to secure help for their missions and the great American purpose in the West, were published in books, newspapers, and Congressional documents. There were other travelers whose descriptions of the great Columbia, the mountains and forests, and the rich valley of the Willamette fed the growing Oregon fever in the United States.

"The migrations that wore deep ruts in the Oregon Trail began in 1841. There were 70 in the so-called Bidwell-Bartleson party which left Independence, Missouri, that year. At Soda Springs, Idaho, the party divided, and about half came on to the Willamette Valley. The emigration of 1842, led by Elijah White, numbered more than



Fur traders began to settle in Willamette Basin in 1812.

100. In the fall of 1842, the introduction of Senator Linn's bill proposing to grant each Oregon settler a section of land free, though it failed to pass, encouraged the Great Migration of nearly 900 in 1843. Estimates of arrivals numbered 1,200 in 1844; 3,000 in 1845; 1,350 in 1846; 4,500 in 1847; and about 700 in 1848."

The motivation in the early settlement



1841 - A wagon train moves west on the Oregon trail.

of the valley was the availability of land. The prevailing image of the valley was that of a beautiful, fertile, and promising savanna, well watered and green, with a mild and healthful climate.

The upper valley pioneers, who emigrated largely from evangelical, Protestant stock and cultures in the American heart-

land were, essentially, settlers—farm and town builders. The pioneering spirit was directed to a permanent settlement; gold rushes had no significant place in this movement. At the mouth of the Willamette, the settler orientation was basically mercantile, under a leadership transplanted largely from New England. The motivation was strongly toward development of shipping and commerce.

Steamboat traffic on Columbia and Willamette Rivers and land transport on stage and wagon routes through the valley played an important part in settlement and development during the early decades. The first railroads in the valley were competing lines which extended south from Portland along each side of the Willamette. The coming of the transcontinental rails through the Columbia Gorge and the connection with California through the valley brought a surge of development. It also brought the beginning of serious exploitation of the great timber resources.

The valley growth over the years, which was based principally on agriculture and forestry, and, in the case of the Portland area, on transportation, commerce, and distribution, has had lasting effects on valley development, character, and attitudes. Growth has been generally conservative, solid, and comparatively steady—without real boom or bust.



1859 - News of Oregon's statehood reaches Salem.

Willamette River ferries.



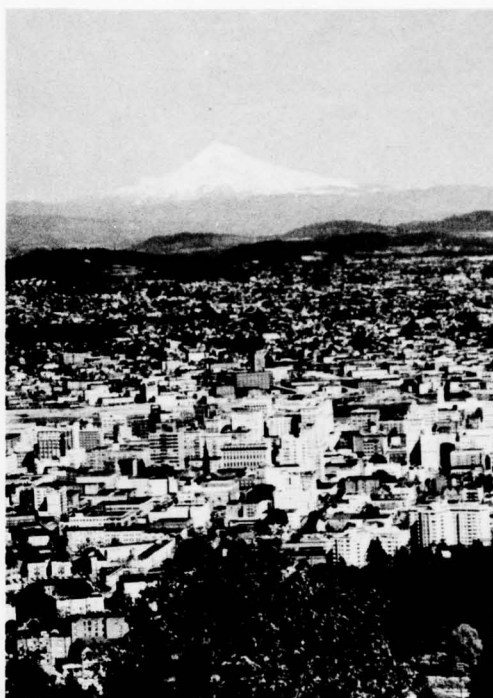
Port of Portland at the turn of the century.



THE PRESENT

Willamette Basin today is a mixture of urban development and the rural setting of the past. Metropolitan Portland, and urban centers of Salem and Eugene-Springfield, are surrounded by agricultural valley lands and densely forested foothills and mountain slopes. Much of the valley is dotted with rural communities and small towns. Few places on the valley floor are more than a few miles from a community; in the foothill and mountain areas, communities are strung at infrequent intervals along the highways linking the basin with surrounding areas. The basin is an area of interwoven contrast. Truck farms lie adjacent to urban centers; century old farms, some with original buildings, are within a few miles of Salem; glacial mountains are within an hour's drive of the major cities; and forests are being logged in sight of city centers.

The basin, with a 1965 population of 1.34 million, contains about 68 percent of the population of the State. Three-fourths of the basin residents live in urban areas, and most live within 10 miles of Willamette River.



Looking toward Mt. Hood from Portland.



Rural hillside west of Salem.

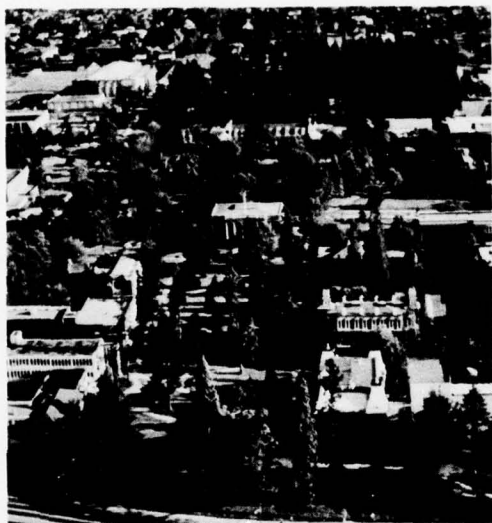
⬢ Portland city center and harbor.



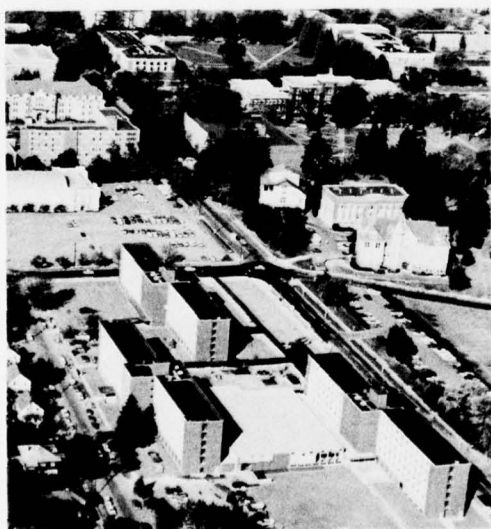
⬢ Mt. Hood - Willamette River.



The basin is the major center of business, commerce, government, and learning in Oregon. Portland, Eugene, and Salem are the largest cities in the State. Portland serves as center of not only the immediate surrounding areas but also for a considerable portion of the State and region. Governmental affairs at the State level are centered in Salem (the State Capital), on

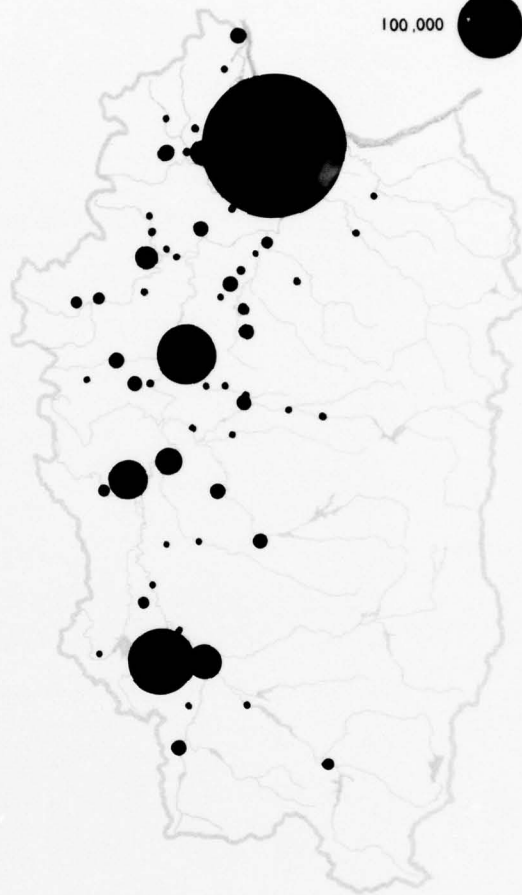
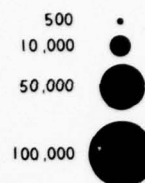


University of Oregon, Eugene.



Oregon State University, Corvallis.

POPULATION CENTERS - 1965
Number of People



the Federal level at Portland. Eugene is the dominant trade center for all of southwestern Oregon.

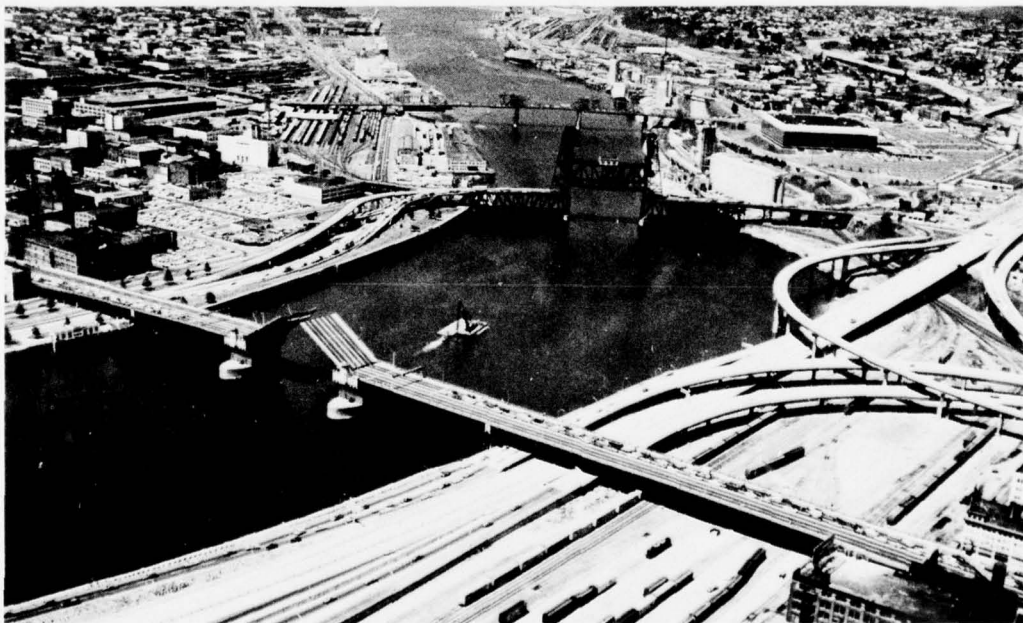
Portland is the largest fresh water, and the leading dry cargo, port on the Pacific Coast. It is the northern terminus of the Southern Pacific Railroad and a western terminus for the Union Pacific and Burlington Northern Railroads; the latter line includes the former Northern Pacific, Great Northern, and Spokane, Portland and Seattle Railways, all of which served Portland. Willamette Basin is completely traversed in a north-south direction by Inter-



Portland's lower harbor and railway terminal.

state Highway 5. Interstate Highway 80N provides Portland with a connection to the east. Other Federal and State roads connect the basin to surrounding areas. Secondary roads complete a comprehensive network

throughout the basin. Air service is available at several communities; Portland International Airport handles the majority of air traffic, and is on numerous national and international flight schedules.



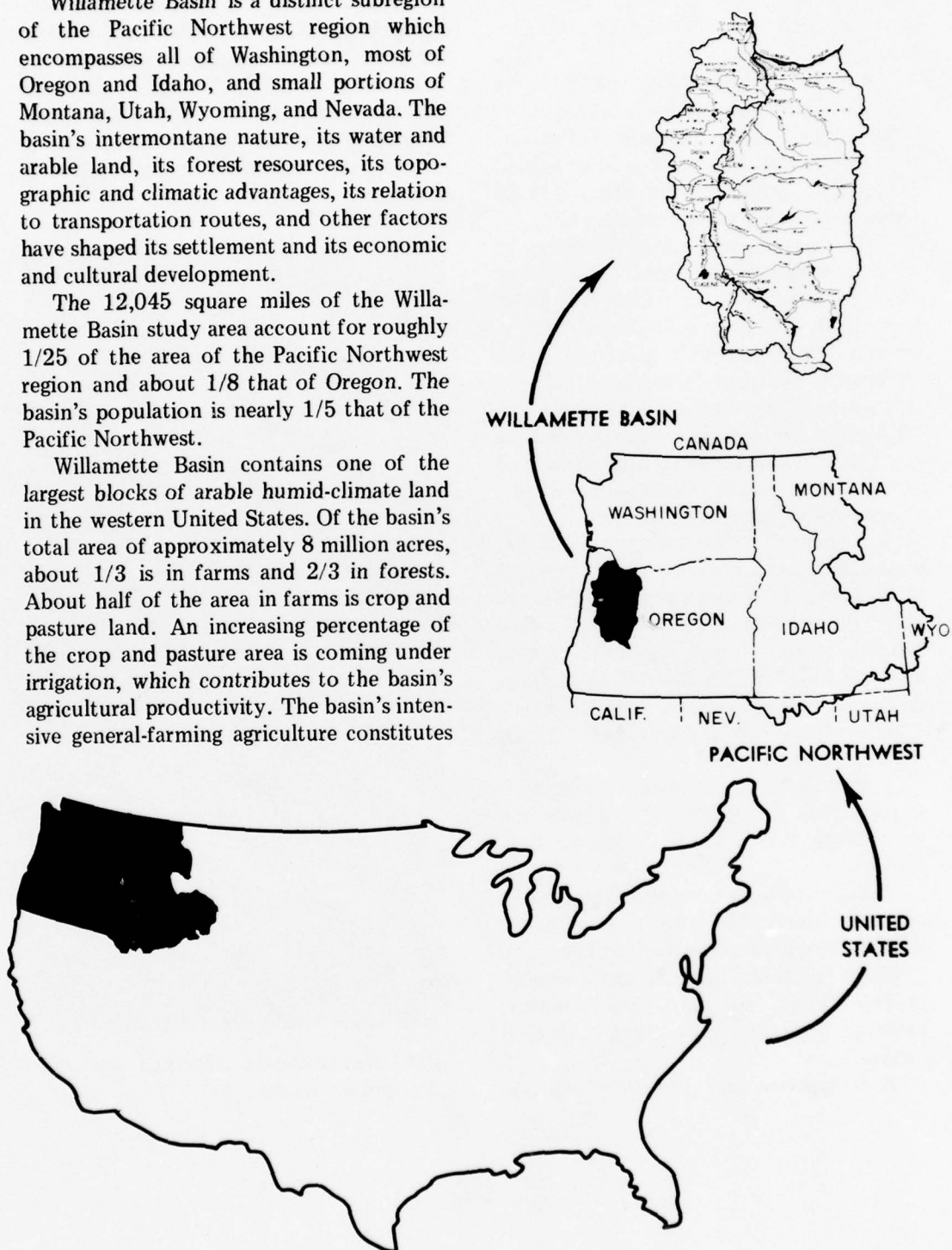
Transportation hub - Portland.

REGIONAL TIES

Willamette Basin is a distinct subregion of the Pacific Northwest region which encompasses all of Washington, most of Oregon and Idaho, and small portions of Montana, Utah, Wyoming, and Nevada. The basin's intermontane nature, its water and arable land, its forest resources, its topographic and climatic advantages, its relation to transportation routes, and other factors have shaped its settlement and its economic and cultural development.

The 12,045 square miles of the Willamette Basin study area account for roughly 1/25 of the area of the Pacific Northwest region and about 1/8 that of Oregon. The basin's population is nearly 1/5 that of the Pacific Northwest.

Willamette Basin contains one of the largest blocks of arable humid-climate land in the western United States. Of the basin's total area of approximately 8 million acres, about 1/3 is in farms and 2/3 in forests. About half of the area in farms is crop and pasture land. An increasing percentage of the crop and pasture area is coming under irrigation, which contributes to the basin's agricultural productivity. The basin's intensive general-farming agriculture constitutes



a substantial part of the Pacific Northwest's total production of food and fiber. The food-processing industries of the basin serve regional, national and foreign markets.

The forest resources of the basin are extensive and highly productive, supporting a complex of major industries and serving national markets. The basin produces about 1/10 of the nation's lumber, and 1/3 of the nation's softwood veneer and plywood.

Willamette River's annual discharge of 24 million acre-feet is about 1/11 that of all of the streams of the Pacific Northwest and about 1/7 that of Columbia River. Among the Columbia's tributaries, the Willamette discharge is exceeded only by that of the Snake. In wider perspective, the Willamette has a higher water yield than any other stream in the continental United States west of the Continental Divide, excepting the Columbia and Snake.

Transportation development east and west along the Columbia provides a regional tie as do routes north and south through the Puget-Willamette trough. The Columbia-Snake inland waterway system and the lower Willamette-Columbia deep-draft channel have played and will play a significant role in regional and national development.

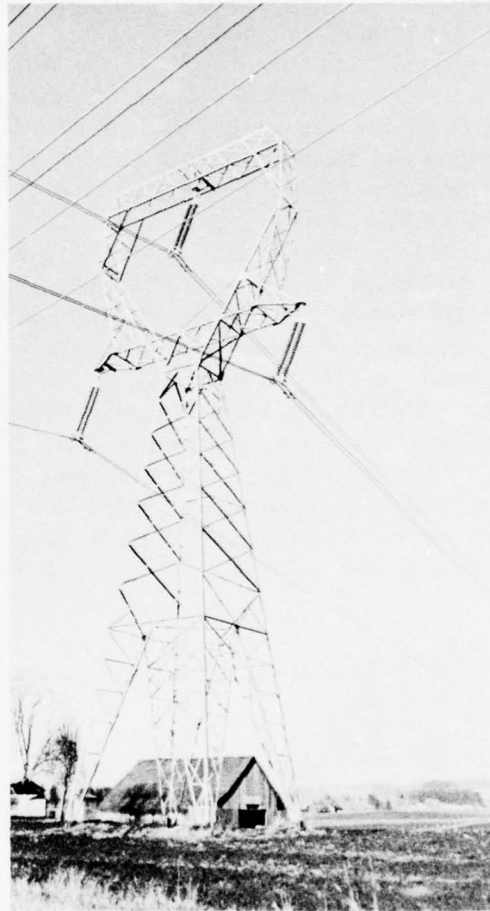
Anadromous fish spawned and reared in the basin are caught in Columbia River and the Pacific Ocean from Alaska to California.

Power supply and demands are also of a regional nature. The basin utilized about 1/4 of the regional power load in 1965.

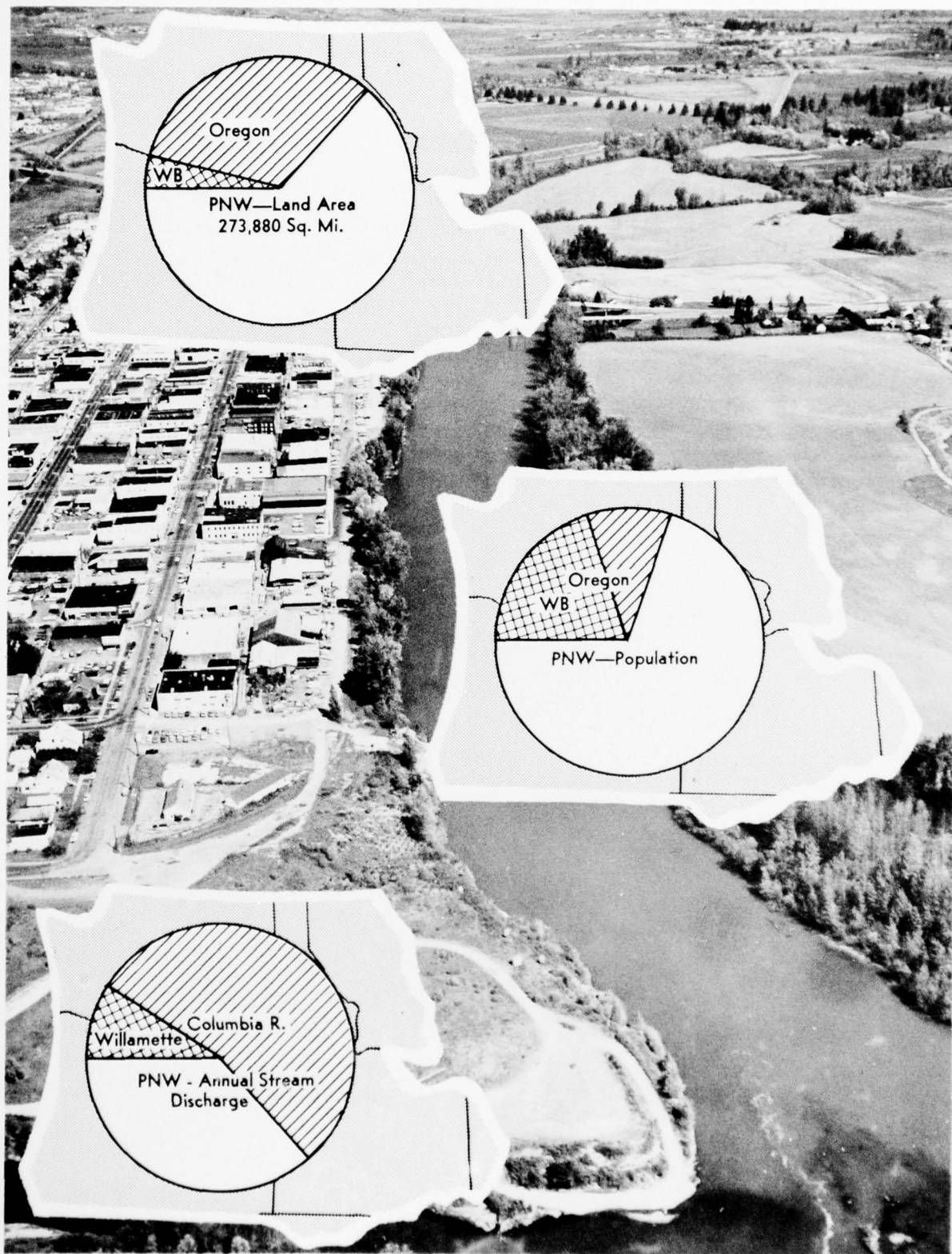
Basin goods and products are marketed in the Orient, the east, and midwest; however, California is the area's principal market.

It is apparent that the future will see

increasing interdependence between Willamette Basin and the rest of the Pacific Northwest Region. The pressure of expanding population in the whole region will force the various subregions, including the Willamette, to adopt a regional outlook. The specialized products of the basin have become a regional resource in terms of meeting regional needs for a productive economy.



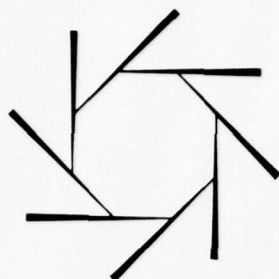
Willamette Basin imports much of its power needs.



*God has lent us the earth for our life.
It is a great entail.
It belongs as much to those who follow us as it
does to us
And we have no right, by anything we may do
or neglect to do,
To involve them in unnecessary penalties,
Or to deprive them of the benefit
Which we have in our power to bequeath.*

*John Ruskin
1819-1900*





THE BASIN

LAND

Willamette Basin is geologically young. Even the dinosaurs had become extinct before formation of Willamette Basin began. In fact, all rock exposed in the basin has been laid down within the last 50 million years.

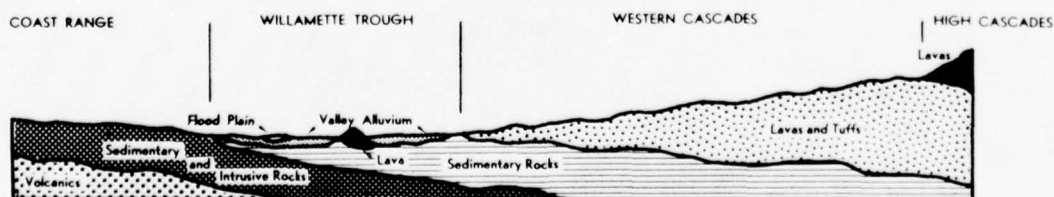
About 20 million years ago, the western part of the basin was covered by the sea, and the eastern part was a terrace-like area of sediments derived mostly from volcanic rock. Then the western part was uplifted, and most of the basin area was eroded to a surface of low relief. Great lava flows, which are still preserved in the Columbia Plateau to the east, then poured out over this plane surface. Next, the Coast and Cascade Range areas were warped upward, the Willamette Valley area downwarped, and Willamette Basin as we know it began to take shape.

Massive erosion then took place, filling the valley and greatly cutting the ranges. Outlying remnants of the lava flows were left on the valley floor as hills and buttes.

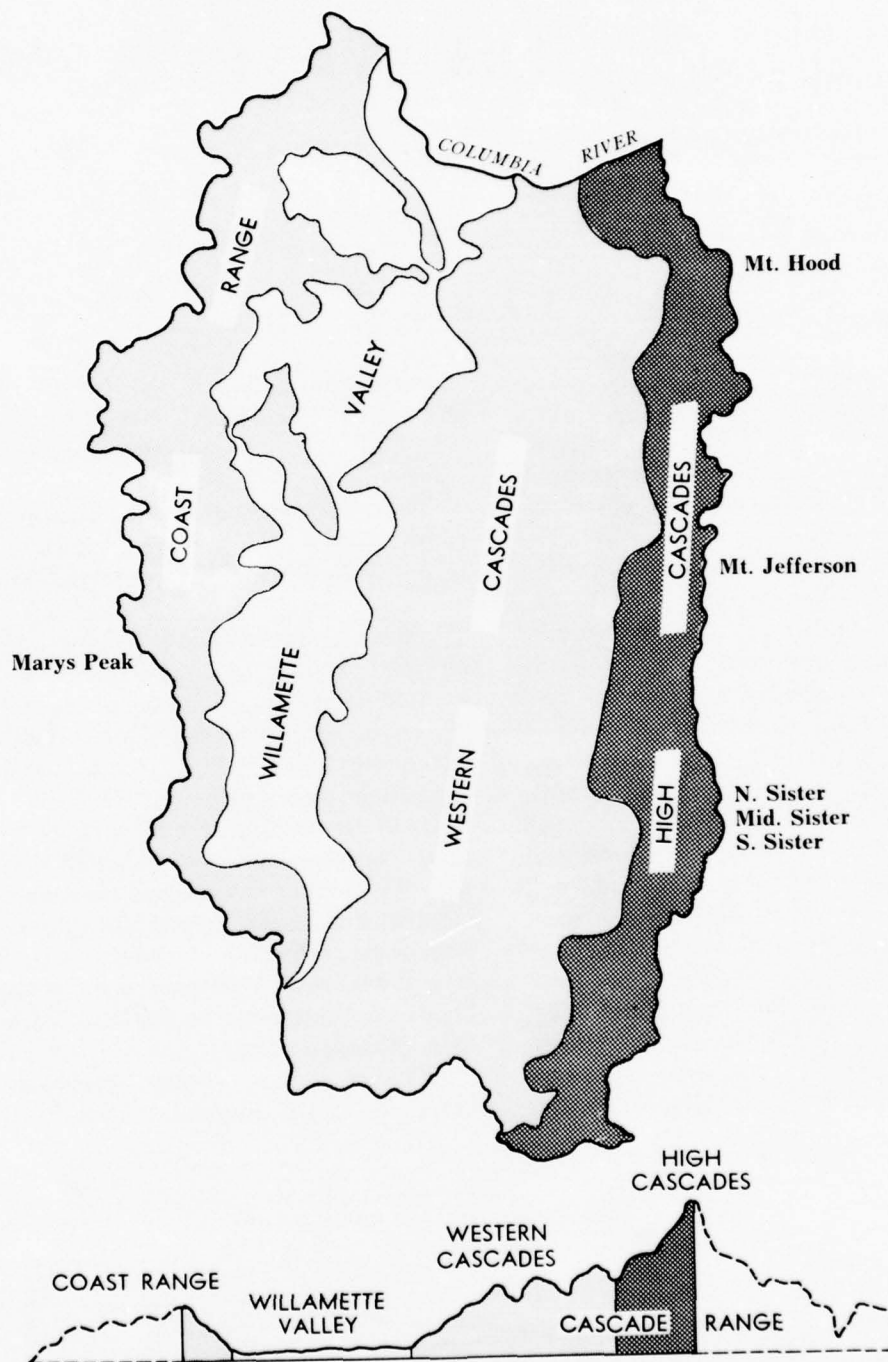
A few million years ago, the High Cascade area on the eastern perimeter of the basin was built up to its present heights by volcanic action.

The finishing touches were put on the basin by glaciers during the great Ice Age. In the Cascade Range, canyons were carved near Mt. Hood, Mt. Jefferson, and the Three Sisters, and several lake basins, notably Waldo Lake, were created. Sea level was lowered and large valleys were cut by lower Willamette and Columbia Rivers. Parts of Willamette Valley were covered by a huge, short-lived lake which deposited silt. Finally, as the glaciers receded and sea level rose, lower Willamette and Columbia Rivers were drowned by the sea, and the estuaries filled with sediment. Very recent volcanism took place in the High Cascades—the jagged lava fields near McKenzie and Santiam Passes bear testimony to the basin's latest great geological event.

Willamette Valley today appears as a broad, elongated lowland framed by the



Geologic cross-section through central Willamette Basin.



Physiographic units.

foothills and mountains of the Cascade Range to the east and the Coast Range to the west. The valley lowland and the two mountain ranges form the three basic natural land divisions of the basin.

The Coast Range is an extension of a low chain of hills and mountains which start in Washington and extend south, forming the western basin boundary. Crest elevations range from 700 feet in the headwaters of Yamhill River to 4,097 feet, the summit of Marys Peak. The central Coast Range is characterized by sharp ridges, while the foothills and buttes at the Valley's edge are rounded and rolling. The streams in the mountainous areas flow through deep valleys with very high stream gradients. The Coast Range and foothills cover about 1,900 square miles of the basin.

Willamette Valley itself is the Oregon portion or the southern 125 miles of the Puget-Willamette Trough, a broad structural depression extending from Puget Sound to Eugene, Oregon. The valley is crossed at several places by low chains of hills dividing the valley into four lowland areas. In general, each of the lowland areas contains a main valley plain, remnants of at least one higher terrace, and hills or buttes separated from the adjacent mountains by lowland flats.

The western slope of the Cascade Range is the largest of the three land divisions, approximately 7,600 square miles. It includes two distinct sections: the High Cascades and the Western Cascades. The High Cascades, the higher and easternmost part of the slope, are a gently inclined plateau from 5 to about 10 miles wide and



Lava flow formations near the Three Sisters.

about 130 miles long. The plateau surface ranges in altitude from 3,000 to about 5,000 feet and is interrupted at frequent intervals by volcanic cones and by mountains that attain altitudes greater than 10,000 feet. The Western Cascades range from 50 miles wide in the south to 20 miles

wide in the north, and are about 120 miles long. This section ranges in altitude from about 300 feet at the western edge to more than 5,000 feet at the crests of numerous ridges. Major streams are deeply incised and separated by narrow ridges.



*Without water, a man dies. Without water, a community
faces the same fate.*

Leonard A. Sheele

STREAM SYSTEM

The bent twig which set the pattern of Willamette Basin growth was the river system. The first settlers moved inland along the river and their river-oriented settlements became the urban centers of Portland, Oregon City, Salem, Albany, Corvallis, and Eugene.

Willamette River

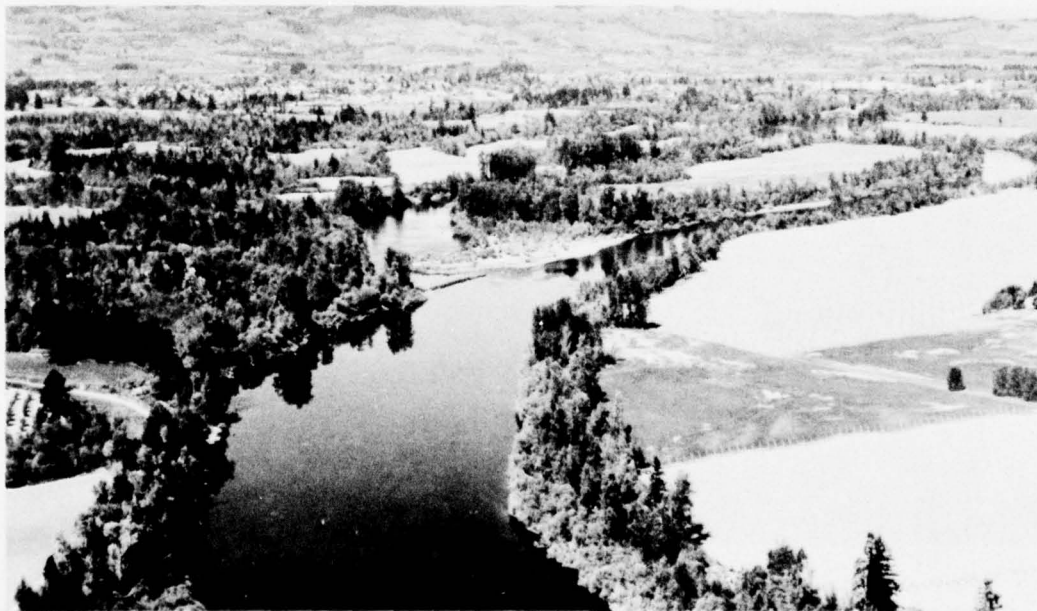
Willamette River is formed by the joining of its Middle and Coast Forks in the southern end of the valley near Eugene. It flows northward (one of the few major rivers in the United States that flows north) for 187 miles to join Columbia River just downstream from Portland.

From Eugene to the Yamhill River mouth (river mile 55), the streambed is a series of long, deep pools and short riffles with a braided, meandering channel. A deep pool extends from about the mouth

of Yamhill River downstream to a low dam and falls at Oregon City. The 26-mile reach from Oregon City to the mouth of the river is a flat section affected by backwater from Columbia River. Tidal effects of the ocean are transmitted to a limited extent through the Columbia to the lower portion of the Willamette.

Tributaries

The major Willamette tributaries rise in the Cascade Range and enter the Willamette from the east. These include Middle Fork Willamette, McKenzie, Santiam, Molalla, and Clackamas Rivers. East side tributaries have relatively steep gradients and for the most part retain a rapid-pool-rapid character throughout their length. The major east side tributaries are also characterized by high base flows sustained



Willamette River south of Salem.

by melting snow and ground storage in porous lavas.

West side tributaries head in the lower elevation Coast Range mountains. Their upper reaches are quite steep; however, they flatten upon reaching the valley floor, thus taking on a slow moving, meandering character. West side tributaries are characterized by low base flows during the summer months.

Sandy River

Sandy River, located in the northeast corner of the basin, drains about five percent of the study area. The stream system originates on the upper slopes of Mt. Hood and drains directly into Columbia River. The river is basically a mountain stream with steep gradients and numerous rapids.

VEGETATION

One theme dominates nature's vegetative artwork in the study area: a predominance of green which distance subdues to blue-green, blue, and finally purple. This singleness of color comes not from artistic whimsy, but from vegetation sustained by rainfall that ranges from 35 inches on the valley floor to more than 180 inches annually in the Coast Range, and from three-fourths of the basin being forested, mostly with evergreen species. Also, fields

of the valley floor are rich with varied greens of mint, beans, corn, feed grains, pasture grass, and seed grass.

Using elevation as a basis, the vegetation of Willamette Basin is divided into four zones: valley, principal forest, upper slope forest, and subalpine forest. Elevation is the primary influence on the climate, which in turn is the principal influence on the vegetation zones.



Our surroundings can enrich or impoverish our lives. Thus, conserving and improving our environment can add immeasurably to private and public happiness.

Hubert H. Humphrey

The valley zone generally lies below the 1,000-foot elevation level and has the driest, warmest climate. The valley zone is the basin's prime agricultural area. Small forest stands (usually less than 500 acres) are scattered among agricultural tracts and now occupy less than 30 percent of the total area. Softwood stands grow on a variety of sites; the most common species is Douglas-fir. Cottonwood, alder, Oregon ash, and bigleaf maple are the most common hardwoods on bottom lands, and white oak is common on drier sites.

The principal forest zone lies between the 1,000- and 4,000-foot elevations. Annual precipitation ranges from 60 to 140 inches, with moderate winter snowfall which accumulates at the 2,000-foot elevation, and temperatures are cooler than in the valley zone. Much of the basin's wood crop is obtained from this zone. Most of this zone is heavily forested; Douglas-fir forests occur in pure stands over large areas. Other common species are western hemlock, western red cedar, and the true firs. Some ponderosa and sugar pine are found above the 2,000-foot elevation.

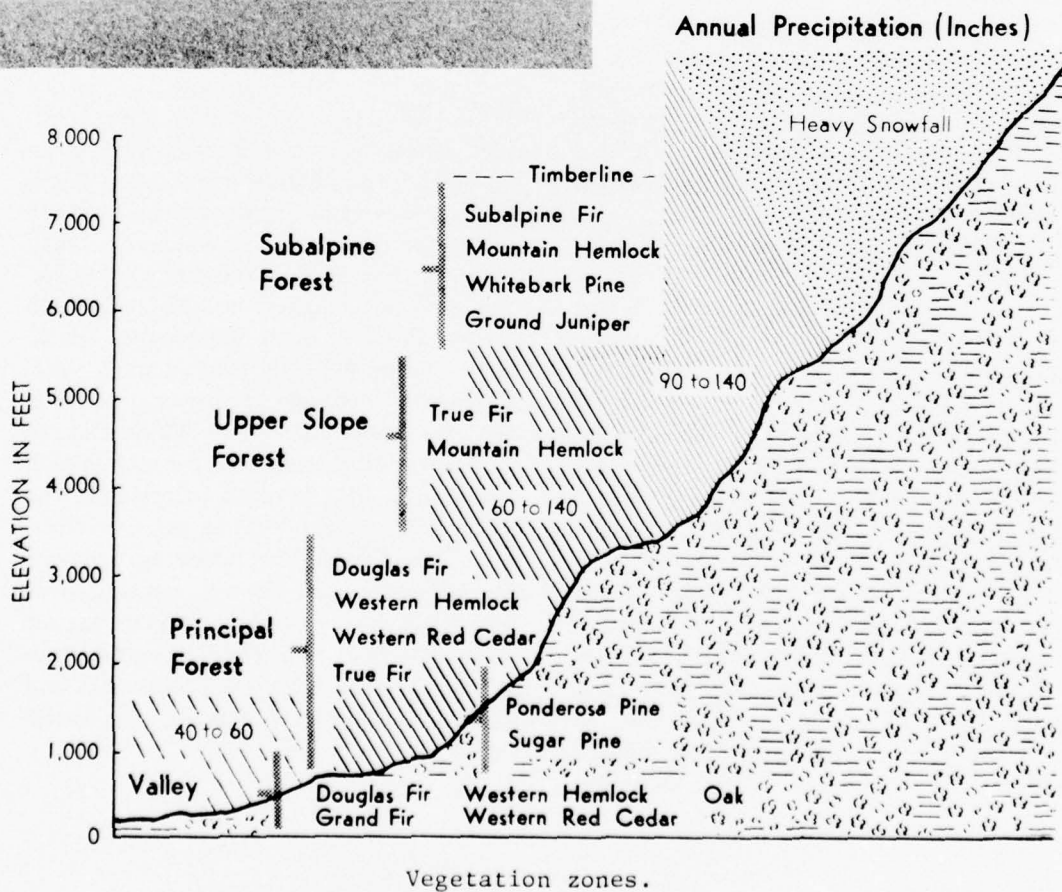
The upper slope forest zone lies between the 3,000- and 6,000-foot elevations. The climate of this zone is moderate except for brief periods of hot weather in summer and cold weather in winter, usually caused by a temporary westward movement of continental interior weather. Precipitation ranges from 90 to 140 inches, and winter snow fall is heavy with large snowpack accumulations. Upper slope forests cover large areas in the Cascade Range, but exist only on the highest peak in the Coast Range. About 80 percent of the zone is commercial forest, the remainder consisting of rock outcrops, meadows, lakes, and non-commercial timber areas. True fir-mountain hemlock stands are predominant and provide a setting for large-scale moun-

tain recreation.

The subalpine forest zone begins at about 5,000- to 6,000-foot elevation in the Cascades and extends to the timberline. It receives heavy snows and has a short growing season, about 30 days. The principal tree species are subalpine fir, mountain hemlock, whitebark pine, and ground juniper, occurring in scattered stands mixed with meadows, barren areas, and lakes. Patches of brush, moss, and lichens are found above timberline.

The timber stands which cover much of the principal forest zone are part of the unique Douglas-fir subregion. Although the Douglas-fir biological range extends over much of the west, it obtains its outstanding character in western Washington and western Oregon. Centuries of unique climatic influences have developed an environment suited to a vegetative system which cannot be found any place else in the world.

Douglas-firs 200 feet high and 3 to 4 feet in diameter are common. Elite specimens have been recorded at heights exceeding 350 feet and diameters between 10 and 15 feet. It does not grow well in the shade and young trees need light to survive. When grown in the shade, Douglas-fir reproduction will not compete satisfactorily with species that are more tolerant of shade. This accounts for the basin's predominantly even-age timber stands. It is also this intolerant nature which dictates the harvesting pattern used for maintaining sustained yields. In order to maintain the species, Douglas-fir must be patch or clear-cut. This allows the necessary sunlight penetration to start the next generation. If Douglas-fir forests are left uncut or are cut selectively, they will, through natural processes, be replaced by western hemlock and true firs, unless fire reopens the forest canopy.



CLIMATE

A winter newcomer to Willamette Basin is likely to conclude that the local jargon, which describes western Oregon residents as webfeet, has a basis in fact. Measurable precipitation falls 150 to 180 days a year, depending on elevation. A summer visitor might be puzzled by the same description after 60 days without rain. The long-term resident is likely to approach the climate philosophically by looking forward to the seasonal changes.

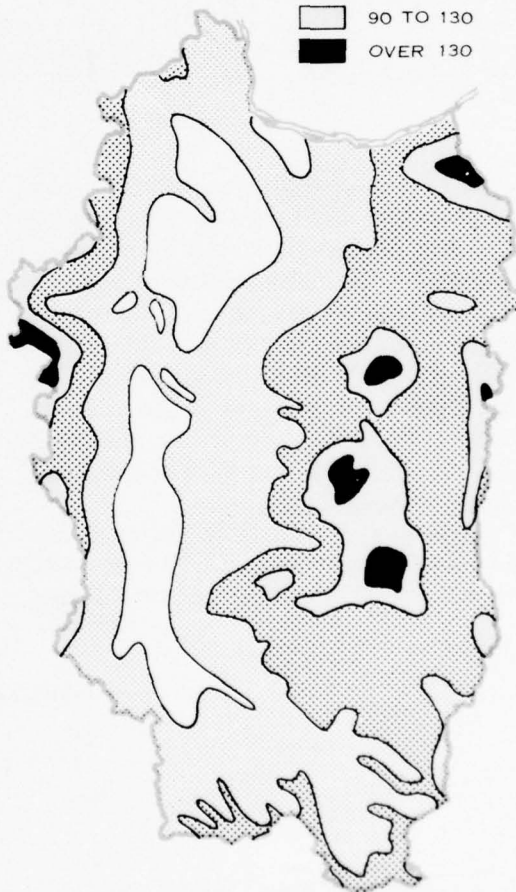
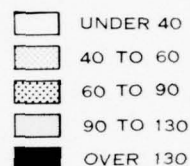
The climate is more technically described as consisting of warm, dry summers and comparatively mild, wet winters. Temperatures of the basin are usually mild. Normal variation between the winter and the summer averages is small, ranging at lower elevations from about 38 degrees Fahrenheit (F.) in January, to 67°F. in July. Minimum temperatures rarely drop below zero and maximums seldom exceed 100 degrees.

Over the valley floor, the average growing season is a little more than 200 days, decreasing to approximately 150 days at the 1,000-foot level. At the highest levels in the Cascades, frost may occur during any month of the year. Normal annual precipitation over the basin is about 60 inches, ranging from 35 inches in the valley to more than 180 inches in the Coast Range. About 70 percent of the annual precipitation normally falls during the 5 months of November through March; less than one percent occurs during the July-August period. Rainless periods of more than 30 days are not uncommon during the summer months. During the summer of 1967, 79 days passed without measurable rainfall.

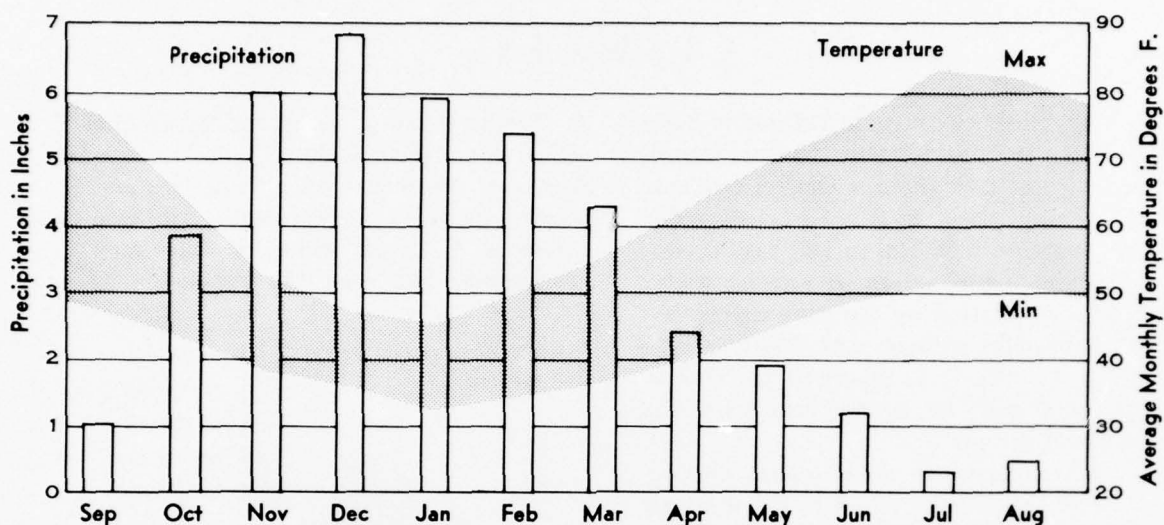
Most of the precipitation that falls at low elevations occurs as rain. The average annual snowfall at Portland (about 40 feet above sea level) is about 9 inches, with a water equivalent of only 2 percent of the mean annual precipitation at that location.

At Portland and at other places on the valley floor, snow seldom accumulates to depths of more than an inch or two and usually melts in a few hours; on rare occasions, 8 to 12 inches of snow may accumulate, but even the heaviest falls

ANNUAL PRECIPITATION
IN INCHES



seldom remain longer than 3 or 4 days. At the 2,000-foot elevation, approximately 10 percent of the average annual precipitation occurs as snowfall. From that elevation to the crest of the mountains, the percentage



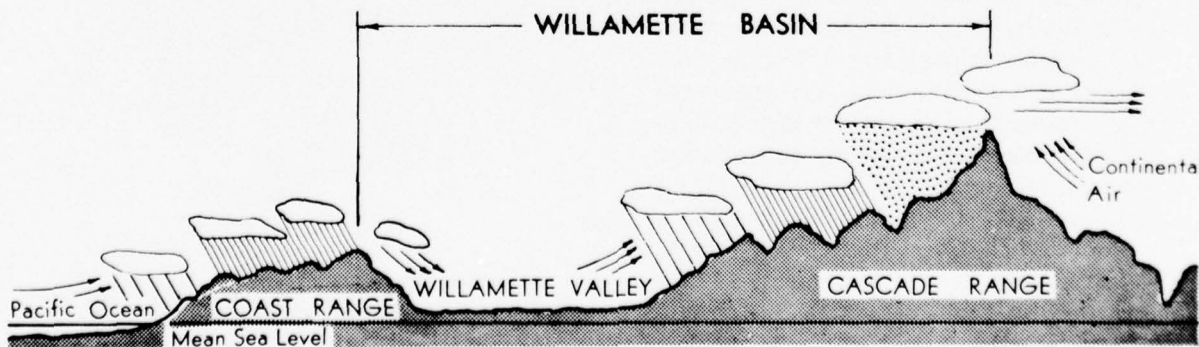
Precipitation and temperature at Salem.

of the annual precipitation falling as snow increases roughly at the rate of 10 percent for each 1,000-foot increase in elevation. At progressively higher elevations the depth of snow becomes greater, and it begins to accumulate earlier in the fall and lasts later in the spring. At the higher elevations along the Cascade Range, such as Government Camp (elev. 3,980), annual snowfall averages nearly 300 inches with accumulated snow depths reaching 15 feet.

Significant variations in basin climate are brought about primarily by four major geographical features: (1) the Pacific

Ocean, (2) the Coast Range, (3) the Cascade Range, and (4) the Columbia Gorge. The first of those largely determines the general characteristics of incoming air-masses, the second modifies the airmasses to some extent before they reach the basin, and the third and fourth bring about variations in climate that take place within the basin.

Willamette Basin is elongated parallel to the coastline of the Pacific Ocean, which lies 40 to 50 miles to the west. Because airmasses generally move from west to east, air reaches the basin soon after completing




Terrain precipitation relationship.

several days of ocean travel. Over the ocean, the air becomes nearly saturated and its temperature in the lower several thousand feet closely approaches that of the water. Also, from mid-October to about early April, the ocean is a vast spawning ground for the winter storms that move, often violently, onto the Oregon Coast.

The Coast Range, whose foothills begin near the Pacific shoreline, extends the full north-south length of Willamette Basin. Those west side mountains, with crests generally between 1,200 and 2,000 feet, intercept the more violent ocean storms, and modify the incoming airmasses before they reach the Willamette and tributary valleys. During the winter, when the land is colder than the ocean, air is cooled as it moves onto the land, both by its passage over the cooler land surface and by its increase in altitude as it moves up the slopes of the Coast Range. This lifting process cools the air materially, reducing the amount of moisture that it can hold and causing precipitation. Much of the moisture falls on the west slopes of the range outside Willamette Basin, but a considerable amount is carried over the crest. The air that moves down into Willamette Valley is much drier than the original marine air. In summer, when the land-masses are warmer than the ocean, the incoming air is heated as it moves onto the land. Even in the Coast Range, temperatures are higher than that of the ocean. At those higher temperatures, the water-retaining capacity of the air is more than enough to offset the cooling due to lifting; therefore, precipitation is less likely to occur during the summer.

The crest of the Cascades that forms the eastern edge of Willamette Basin has an average altitude of slightly more than 5,000 feet. Just as the air is cooled in moving up the Coast Range, it is again cooled as it ascends the west slopes of the Cascades. The greater height of the Cascades pro-

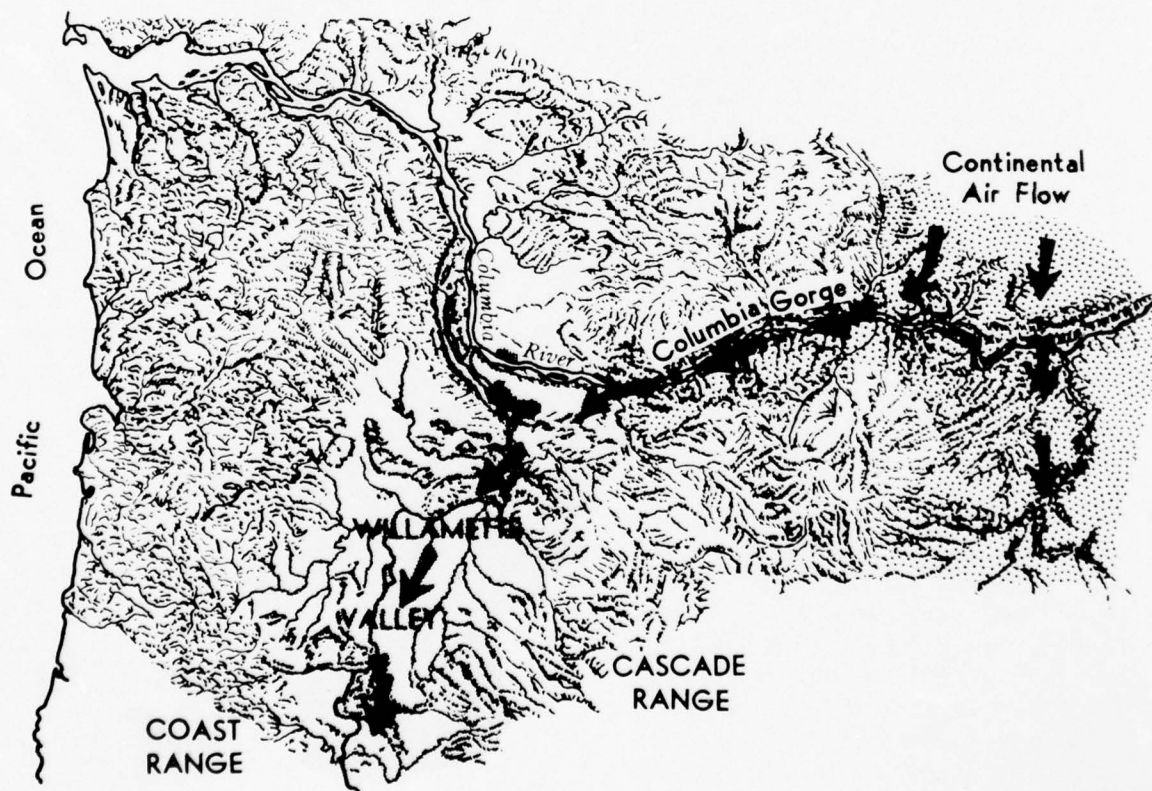
Upper slope forests are high producers of water. 



duces much lower temperatures than in the Coast Range, and a large part of the precipitable moisture falls as snow during the late fall and winter months. The Cascades also block out of Willamette Basin the continental airmasses that move southward along the eastern slopes. As a result, the extreme temperatures of both winter and summer that commonly occur east of the Cascades rarely occur in Willamette Basin.

The Columbia Gorge affects the climate of the extreme lower basin because it affords a near-sea-level route for passage inland of marine air from the west and for the occasional strong push of continental

air from the east. During summer afternoons, when the greatest heating normally occurs east of the Cascades, sea breezes move up the Columbia Gorge to replace rising hot air. This stops further afternoon heating and lowers by several degrees the maximum temperatures that would otherwise occur in at least the northern portion of the basin. Also, in summer, hot, dry continental air from east of the Cascades occasionally pushes through the gorge and causes very low humidities, high temperatures, and east winds. In winter, air may move in from the east in the same way, except it is then very cold, dry air that moves westward through the gorge.



Continental air flow.

A River is more than an Amenity - - it is a Treasure, it offers a necessity of life that must be rationed wisely among those who have power over it.

Oliver Wendell Holmes

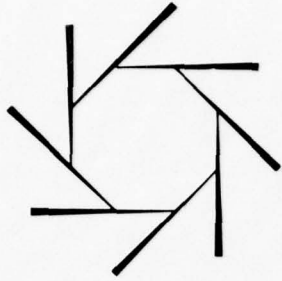
Willamette River south of Newberg.



*... government has as much a duty to protect the land, the air,
the water, the natural environment of man against such (tech-
nological) damage, as it has to protect the country against
foreign enemies and the individual against criminals...*

Vice Admiral H.G. Rickover, U. S. Navy





NATURAL RESOURCES

The dominant motivation for settlement of Willamette Valley was the use of land. The character of development was shaped primarily by the availability of agricultural land, timber, water, and the accessibility by river transportation. This dependence on natural resources not only influenced the early development, character, and attitudes of the area, but has remained as the dominant influence on present growth, development, and basin character.

Early basin residents considered timber stands as deterrent to the basic goal of using land to farm. The basin waterways

were as often an adversary in the annual flood season as they were useful for transportation routes. The rugged land forms presented obstacles to travel, rather than scenic wonders or recreational retreats.

The attitude toward natural resources soon underwent a change to a concept of utilization and often exploitation. Timber was cut to supply at first a local and soon a regional and national demand. The more accessible timber stands were cut first, and cutover areas often were left unseeded. Portions of the basin's ample water supply were also exploited, to carry away urban



Willamette River winds through prime agricultural land.



The river, while serving as a transportation route, brought annual floods to communities along its banks.

and industrial wastes. Lowland areas were drained or filled, reducing habitat for waterfowl and furbearers. Salmon runs were reduced by loss of habitat through construction of dams without fish passage facilities and by impairment of water quality.

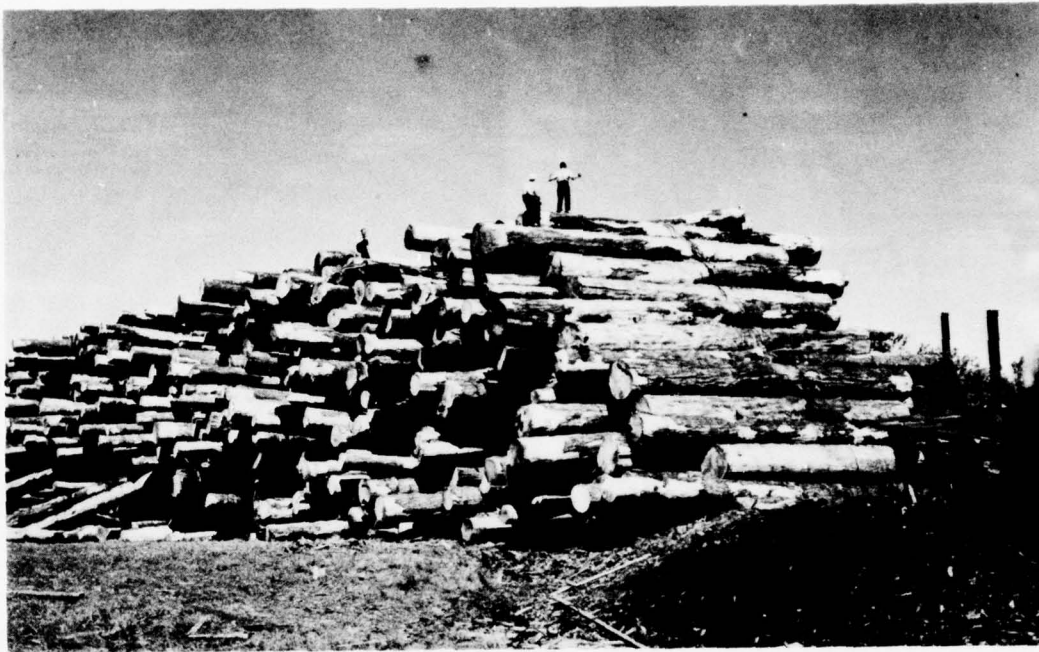
There has been in Willamette Basin, as throughout the country, a basic change in the people's attitude toward their natural resources. Land, water, timber, fish and wildlife, which were once considered inexhaustible resources or challenges to be overcome, are now becoming assets that must be used and maintained, for the growth of the economy and for the preservation of livability.

The exploitation attitude is now giving way to an attitude of resource stewardship. Much of the timber resource is managed on a sustained-yield basis. There are still serious problems of water pollution, but there is a strong trend toward viewing the basin's rivers as a multiple-use resource whose

quality must be maintained to facilitate all uses. Minimum flows have been established by the State to protect fish life and prevent further streamflow depletion. Land forms which were obstacles to travel have become a haven for escape from urban pressures. At least two aspects of this change are significant in planning for use and development of the basin's natural resources.

First, the evolution of thought, from resources as challenges to be overcome to assets to be maintained, has taken place at about the same rate nationally. Since Willamette Basin was developed later than much of the Nation, it was less affected during the period of exploitation than most other areas. It is still two-thirds forested, large areas of primitive environment remain, rivers are still free-flowing, and there are still anadromous fish runs. Thus, there are more choices for planning than in many other parts of the Nation.

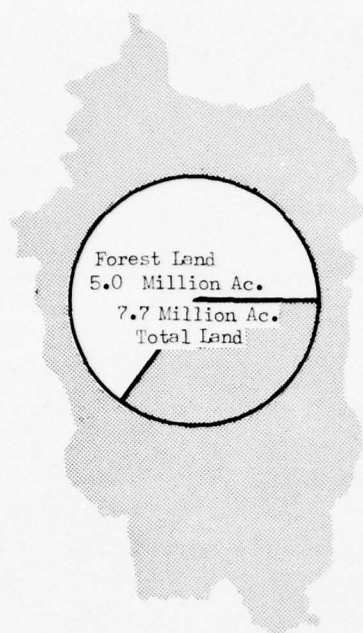
Second, the idea that resources should be maintained is becoming more widely



The exploitation attitude toward the timber resource has given way to management on a sustained yield basis.



The river became a multiple use resource as population and industry expanded.



Forest land in the basin.



Logging in a commercial forest.

accepted. Originally most of the impetus for maintaining resources was economic; it is economically profitable to be good stewards of natural resources, because mills and manufacturing plants require an assured supply of raw materials over long periods of time. Now the impetus is not only economic but environmental. The results of poor stewardship, as reflected in degradation of environment, are becoming increasingly apparent to many people, particularly those who use the basin's natural resources for esthetic and recreational purposes. The already large number of people in this group is increasing rapidly, not only because of greater affluence and more free

time, but also because of needs generated by a way of life with more pressure. Demand for protection of irreplaceable resources, as well as for maintenance of renewable resources, receive much support from this group.

Planning is an evolutionary process that follows the lead of changing attitudes. That lead is clearly toward a stewardship or management concept which recognizes that development and conservation must be considered together rather than as alternatives. Properly planned and implemented development, undertaken with the knowledge of its effect on the total environment, can enhance the livability of the basin.

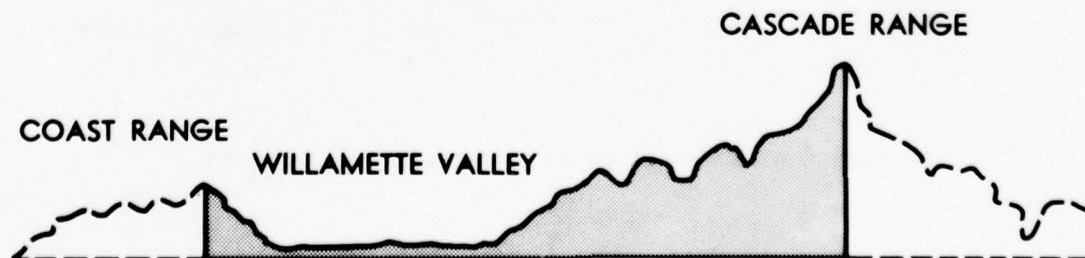
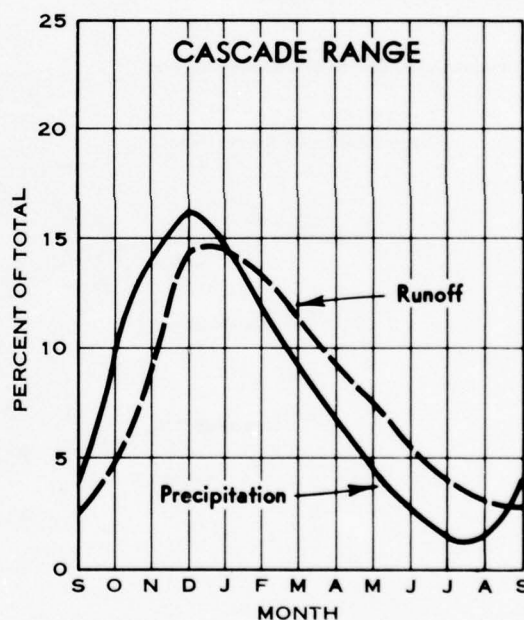
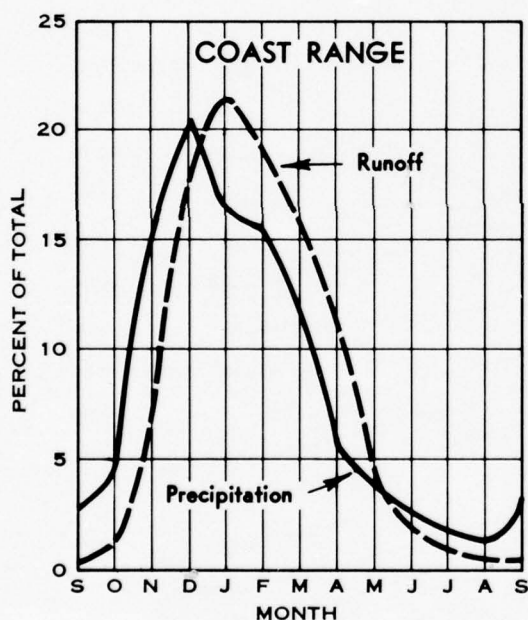
WATER

Surface Water

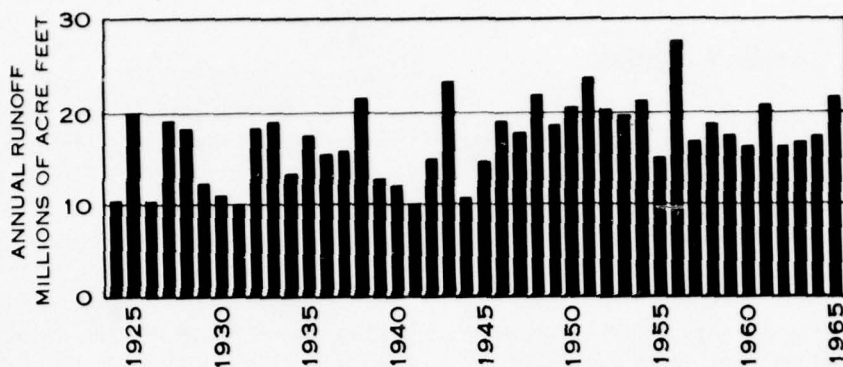
Average annual runoff from the basin's 12,045 square miles is about 26 million acre-feet. Willamette River discharges about 24 million acre-feet, and streams draining directly to the Columbia, principally Sandy River, discharge the remainder. Annual runoff varies considerably from year to year. At Salem, a representative station, Willamette River's discharge varied from a low of 10 million acre-feet to a high of 27 million acre-feet over a period of 42 years; average annual runoff at that station is about 17 million acre-feet.

Runoff throughout the year varies in the same general pattern as precipitation; that is, high flows in the winter and low flows in the summer. There is a difference in the monthly pattern of runoff between those streams originating on the western and eastern sides of the basin. West side streams, such as Marys, Luckiamute, Yamhill, and Tualatin Rivers, rise rapidly from intense rains from October through April and are less affected by snowmelt. After May, the streams recede to their summer low flows.

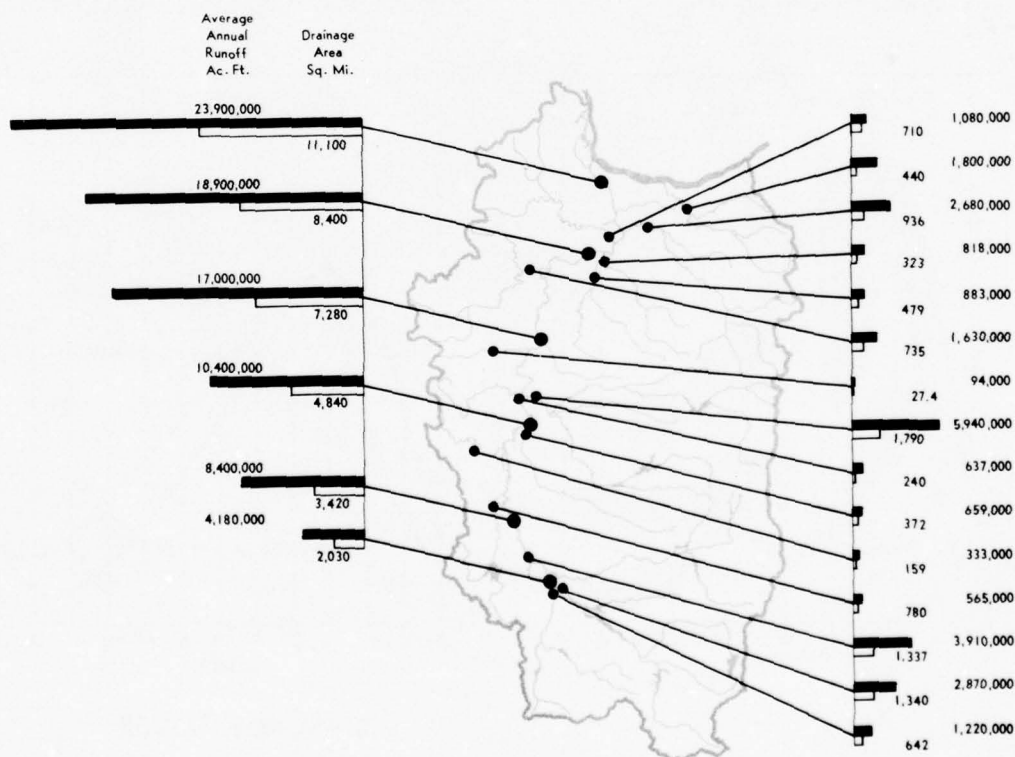
Streams that originate in the Cascade



Seasonal distribution of precipitation and runoff.



Willamette River runoff at Salem.



Average annual runoff at selected stations 1928-63.

Range, such as McKenzie, Santiam, Clackamas, and Sandy Rivers, also rise in the fall, and peak in response to general storms, but maintain high flows through May, then subside gradually. The yields of the Cascade streams reflect the impact of winter precipitation occurring largely as snowfall, and the effects of natural storage in the porous lavas of the high Cascades. Moderate floods occur when the snow melts in the spring. The base flows are better sustained throughout the year than those of the Coast Range. Streams gradually recede to their summer low flows by August.

Floods occur in Willamette Basin nearly every year, and two or more times in an unusually wet year. As an example, at Albany, during the 73-year period 1893 through 1965, bankfull stage has been exceeded 126 times, and on 15 of those occasions stages have exceeded bankfull by 10 feet or more.

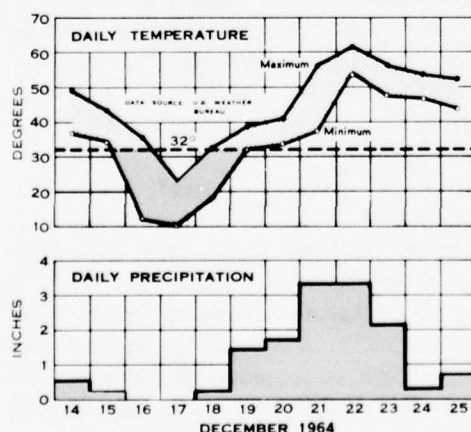
The largest flood of historic record at Salem occurred in 1861, when Willamette River rose to a peak stage of 47.0 feet, with an estimated discharge of 500,000 second-feet, 21 feet over flood stage level. The second largest flood at Salem (December 1964) was reduced from what would have been a stage of 45.3 feet (472,000 cfs) to

37.8 feet (309,000 cfs) by reservoir regulation. Other recent major floods in the basin occurred in December 1955 and February 1961.

Willamette Basin floods generally result from rainfall augmented by snowmelt. When melting snow combines with heavy precipitation, as in December 1964, a larger-than-normal runoff occurs. During late spring or early summer, melting snows in the Cascade Range may cause minor freshets on the east side tributaries and Willamette River; however, floods from that cause usually are relatively small. Below the falls at Oregon City, backwater from the annual Columbia River freshets causes high stages on Willamette River during May, June and July. The highest stages of record in the Portland Harbor have resulted from Columbia River backwater.

In 1910, the U.S. Geological Survey began collecting daily samples of surface water at four locations in Willamette Basin for chemical analysis. The data showed the basin's water to be soft, low in dissolved-solids content, and notably uniform in chemical composition. Recent data indicate no detectable change in chemical composition.

Willamette River and its tributaries



Melting snow and heavy precipitation combined to make the conditions that resulted in the December 1964 Flood.



Dec. 1964 flood - subdivision north of Salem on Willamette River.

transport small quantities of sediment compared to quantities carried by other major rivers of the country. For example, the sediment discharge of Colorado River at Grand Canyon, Arizona, averages about 96 million tons per year—about 42 times that for Willamette River at Portland, although the mean water discharge at Grand Canyon is only about half that of the Willamette.

Natural sediment yield in the basin is low because of a favorable combination of physiographic, vegetative, and climatic factors. The average intensity of rainfall sustained over a 2-hour period in the main part of Willamette Basin is less than one-half inch per hour. The rain falls gently over a prolonged period. This, with the generally high organic matter content of the soils and the lush vegetation that absorbs the pounding action of raindrops, has created a porous soil mantle. Much of the rainfall enters the soil, with a portion returning through springs and seeps to feed the surface flowing streams. The soil mantle is generally moderately deep to deep.

The cultivation of sloping and hill lands, construction of logging roads, and occurrence of fires have all increased sediments in the streams, however.

Water temperatures range from 32°F. to 83°F., depending on stream and time of year. Critical months are July and August when temperature is highest and stream-flow is lowest. Because they rise in the higher, cooler Cascade Range, east side tributaries tend to have lower water temperature than the west side streams.

Ground Water

Willamette Basin has a large volume of water in natural underground aquifers. The quantity of water available at various locations ranges from meager in parts of the Coast Range to copious in parts of the valley floor and the Cascade Range. Ground water in storage represents an integral part of the basin's water resource that can be managed.

Aquifers in sedimentary and volcanic

rocks are the major ground water reservoirs in Willamette Basin. Those aquifers are the sand and gravel layers in the valley fill, lavas of the Columbia River group that form the hills and mountains, and the young lava rocks of the High Cascades. The volcanic aquifers of the Cascade Range serve an important hydrologic function by sustaining the flows of streams draining that area.

Unconsolidated and semiconsolidated water-bearing materials extend to depths of more than a hundred feet in the southern part of Willamette Valley and to several hundred feet in the north part. At an estimated specific yield of 15 percent, nearly 5,000 acre-feet of water would be available from each 50 feet of saturated material underlying each square mile. Thus, a 50-foot zone beneath the 2,500-square mile lowland part of the valley would contain at least 12 million acre-feet of water. Assuming that half that water could be recovered economically, the total usable volume of ground water in a 50-foot zone of the valley is about 6 million acre-feet.





The basaltic lavas of the Columbia River group, although low in specific yield, may contain about 600,000 acre-feet of recoverable water. This estimate is based on an assumed specific yield of 1 percent; each square mile underlain by the basalt would thus contain 640 acre-feet of water for each 100 feet saturated. The entire unit extends over about 1,000 square miles in the basin.

Ground water of good quality is available throughout most of Willamette Basin.

The concentrations of most constituents are within the limits recommended for drinking water by the U.S. Public Health Service. The chemical quality of most ground water also is suitable for industrial and agricultural use. Excessive concentrations of some dissolved minerals, notably iron and arsenic, occur in places. Saline water is found in a few wells and springs, principally from bedrock sources; it is not thought to be widespread.

AVAILABLE GROUND WATER

Yield varies locally in most areas
YIELD IN GPM

-  MORE THAN 500
-  50 TO 500
-  LESS THAN 50
-  UNKNOWN



FOREST LANDS

About two-thirds of Willamette Basin is commercial forest land; i.e., land producing or capable of producing usable crops of wood, economically available for timber harvest, and not withdrawn from timber harvest. That single fact has dominated both the character of the people and the thrust of the economy throughout the basin's history. And, in spite of the large volume of timber cut during past decades, most of the commercial forest area is well stocked. It is expected, then, that the basin's forest resources will continue to be a major factor in basin life.

The forested areas are predominantly in the uplands. The Willamette Valley floor has small areas of forest interspersed among agricultural and urban tracts.

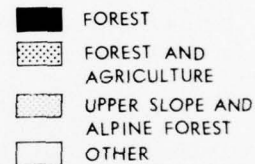
A principal use of forest land is timber production. Commercial forest lands contain almost 150 billion board feet of saw timber and more than 25 billion cubic feet of growing stock. Most of the total is softwood, and most of the softwood is Douglas fir. The present annual harvest is in the order of 3 billion board feet. More than 400 primary wood-using industries convert the harvest to lumber, plywood, pulp and paper, and wood residue products such as chipboard. Forest lands also provide a substantial part of the environment for fish and wildlife and for recreational use. Most of the runoff of the basin drains from forest land.

Ownership of forest land is evenly divided between public and private. However, four-fifths of the available first-growth timber is on public lands. During the first half of this century, cutting was confined primarily to private lands because public lands were remote and relatively inaccessible. The majority of old-growth timber is now harvested from the public lands, while the private lands are producing second- and third-generation crops.

About 80 percent of the public land is in four National forests. Their rank in order

of land holdings within the basin is: Willamette, Mt. Hood, Umpqua, and Siuslaw National Forests. The first three cover the headwaters of tributaries in the Cascade Range system, while the Siuslaw is in the Coast Range. About 16 percent of the public land is administered by the Bureau of Land Management; these holdings are in blocks of one to several sections scattered throughout the Coast Range and foothills of the Cascades. Most of the remaining public land is State, county, and municipal lands distributed throughout the basin.

LAND USE



Private forest lands, widely dispersed throughout the basin, amount to about 2.5 million acres. Those lands range from very small woodlands on individual family farms to large tracts of forest lands which are part of industrial forest operations. About 40 percent of the privately owned forest land is in "large private" ownerships (more than 5,000 acres each). These ownerships amount to about 1 million acres, most of which are integrated into industrial forestry operations.

Although old-growth timber is still the dominant raw material for wood-using industries of Willamette River Basin, young-growth timber is increasing in importance. The remaining commercial old-growth timber probably will be completely harvested in about 90 years. Therefore, the potential sustained growth of the basin's forests is of importance in determining how much raw material will be available annually. The long-term sustained annual yield of the basin's forests probably will be about 3 billion board feet of wood fiber.



Balloon logging research aimed at reducing damage to surrounding area during harvest.



The sustained yield of Willamette Basin forests is likely to be 3 billion board feet of wood fiber annually.

AGRICULTURAL LANDS

Settlers first came to Willamette Valley for land—land they could farm to support themselves. They were attracted by the promise of a region of fertile soils and ample water supply. The valley lands were indeed as promised, and thus agriculture became and remains today a major use of land.

Willamette Basin is adapted to the production of a wide variety of agricultural crops and commodities. Contributing factors are a temperate climate, fertile soil with broad land capability, and abundant water. Each factor is responsible, in part, for the type of agriculture that has developed. The combination of those physical factors, together with their economic advantages, has made Willamette Basin the Nation's leader in the production of a number of specialized crops.

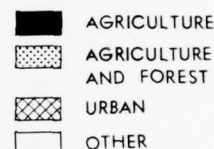
There are 2.8 million acres in the basin suitable for cultivation. Present agricultural land totals 2.2 million acres. The remaining 0.6 million acres is land which is suitable for agriculture, but is presently forested or in urban use. Of the 2.2 million acres, 1.5 million is cropland and 0.7 million is grazing land. About a sixth of the cropland is irrigated; another 10 percent is presently idle.

Lands in the basin have been grouped according to their capability to produce crops without deterioration over time. The basin contains 172,000 acres of soils that are suited to a wide variety of plants and may be used safely for cultivated crops. There are some 906,000 acres which have some limitations that reduce the choice of plants or require moderate conservation practices. About 852,000 acres have severe limitations that reduce the choice of plants or require special conservation practices. Eight-hundred seventy-two thousand acres have soils with very severe limitations that restrict the choice of plants, require very careful management, or both.

Drainage deficiency constitutes one of the major problems on agricultural lands of the basin. Some 1.3 million acres have an excessive wetness problem caused either by a high water table, poor internal drainage characteristics of the soil, inadequate drainage outlets, or overflow conditions. Crop adaptability and yield are limited on these lands.

Climatically, the basin is suitable for growth of many crops without irrigation. However, the trend in crop production is

LAND USE



toward specialization and intensification, which are primarily dependent on irrigation. Some 244,000 acres are now irrigated and about 1,488,000 additional acres are potentially irrigable. Irrigation is so important to the quality and quantity of most vegetables and many fruits that food processors require irrigation as a condition to contracting with growers.

Of the cropland, about 29 percent is devoted to improved pastures, hay, or forage, including both dry and irrigated land. Portions of this cropland are very productive and support a substantial livestock industry. Grain, mostly wheat and barley, and grass seed are closely related to the livestock industry in that grain supplies winter feed, and grass crops supply winter pasture.

The basin leads the Nation in produc-

tion of such seed crops as Merion bluegrass, chewings fescue, red fescue, bentgrass, crimson clover, common ryegrass, and perennial ryegrass. It also ranks high in the production of many other seed crops and is an important producer of certified seed.

Although row crops and specialty crops are grown on a relatively small acreage, their contribution to the economy of Willamette Basin is of major importance. Nearly all of these crops are processed locally. The Salem area is one of the most important centers in the Nation for the processing of fruits and vegetables. Willamette Basin supplies about 14 percent of the Nation's processed snap beans and most of the superior-quality sweet corn. The basin also produces almost all of the filberts grown in the Nation.



Willamette Basin agricultural lands produce a wide variety of crops.

MINERALS

Mineral production in Willamette Basin has an average annual value of about \$20 million. Most of the production value is in sand, gravel, stone, and cement. Almost all such production is used locally for general construction and for roadbuilding and maintenance projects.

Sand-and-gravel deposits are the base for about half the total mineral production value. Only near Portland, where extensive commercial dredging has taken place, is there presently a shortage of sand and

gravel in the streambeds. Private lands are being mined in some areas on the floodplain.

Based on present knowledge, reserves and potential for metallic minerals and fuels are limited. Total value of all production since 1900 for mercury, gold, silver, copper, lead, and zinc is less than \$3 million. The few available coal deposits have been little used, and no petroleum or natural gas reserves have been discovered.

FISH AND WILDLIFE

The basin's fish and wildlife resources have a significance that extends beyond their economic importance. They are varied, extensive and productive, and constitute a highly significant aspect of the area's environment. The pioneer heritage, which orients the Willamette resident to his natural environment, has remained as a part of the regional character. A large number of people fish and hunt, and the great majority of the population recognizes that fish and wildlife resources are one of the threads of the total environment that makes Willamette Basin a desirable place to live.

Nearly all of the thousands of miles of streams, hundreds of mountain lakes, and a dozen or so large reservoirs furnish habitat for resident fish such as rainbow, brook, cutthroat and golden trout, and Kokanee. The Willamette system serves as a migration route, spawning area, and rearing area for several anadromous species—coho and chinook salmon, steelhead trout and shad. Salmon spawned in the basin are an international resource—they are caught not only within the basin and in Columbia River, but also along the Pacific shore from Alaska to California.

Thousands of anadromous fish migrate into the basin every year. Many of these are hatchery fish. In 1965, 58,000 coho sal-

mon and 26,000 winter steelhead trout entered streams of the basin; those runs were about average. The 1962-64 average for spring chinook was 36,500. About 10,500 coho, 14,300 winter steelhead, and 31,000 spring chinook ascended Willamette Falls, while the remainder entered Sandy and Clackamas rivers and a few small tributaries below the falls. A small but rapidly increasing run of fall chinook now ascends Willamette Falls and spawns upstream. With lessened pollution problems in the lower river and the new passage facilities at Willamette Falls, fall chinook may well become the most important run of anadromous fish in Willamette Basin—the potential escapement past Willamette Falls is estimated to be 100,000 or more fish. Those fish will spawn in the main Willamette and the lower portions of the larger tributaries.

Other cold water species in Willamette River include American shad, white sturgeon, and resident cutthroat trout. Shad spawn in May, June, and July, mostly between the river's mouth and Willamette Falls, and a few pass over the fishway. White sturgeon are common, particularly below the falls. Resident cutthroat trout commonly leave the Willamette in winter and spring to spawn in tributary streams.

During the summer, warm water in the lower Willamette, especially in sloughs and

Pond ducks are in
Willamette Basin
all year around.



oxbow lakes, provides favorable environment for warm-water game fish. Large-mouth bass, bluegill, white crappie, black crappie, yellow perch, bullhead catfish, and warmouth bass are the predominant species. Channel catfish, stocked in recent years, are becoming established.

Wildlife species vary considerably in population within Willamette Basin. However, from an ecological view, each species is important regardless of population, since it is a part of the natural scene. Thus, the basin's whistling swan population of 1,000, its elk population of 2,000, and its cougar population of 50 must all be considered significant segments of the total environment.

Big-game species include black-tailed deer, Roosevelt elk, and black bear. Black-tailed deer are by far the most populous, ranging over the entire basin except in urban areas or in mature coniferous forests; their present estimated population is 135,000. Roosevelt elk inhabit the mountainous areas, especially the drainages of McKenzie and Middle Fork Willamette

Rivers, but number only about 2,000; however, their population is increasing yearly. Black bear may be found throughout the forested and less developed areas; their population in the basin is estimated to be 14,000.

The basin provides habitat for a number of upland game species, including ring-necked pheasant, quail, doves, grouse, and rabbits.

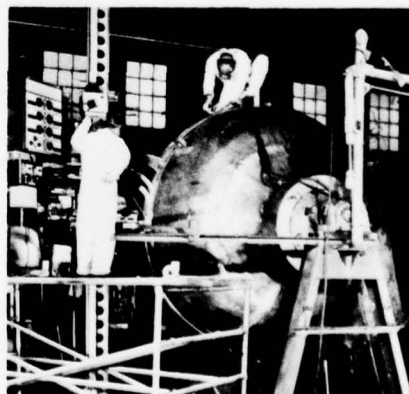
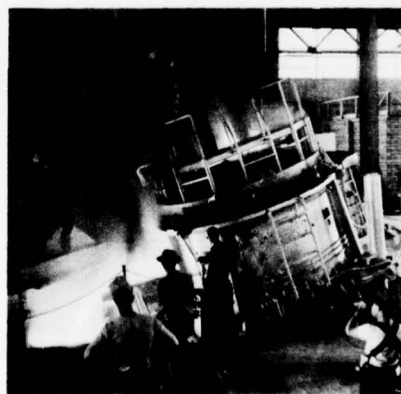
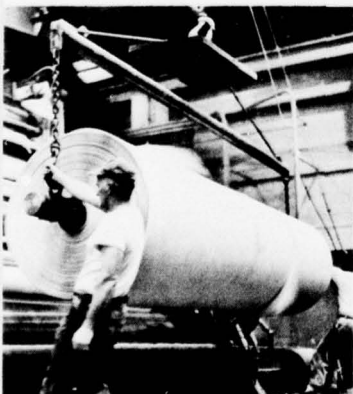
Willamette Basin is located along the Pacific Flyway, one of the major migratory-bird routes on the continent of North America. During the fall and early winter Canada geese use the wetlands, lakes, reservoirs, and larger streams on the valley floor for resting areas and feed in nearby fields and pastures. Wintering populations have averaged about 14,400 birds in recent years. Pond ducks, on the other hand, are present all year around and nest along nearly all streams, lakes, and reservoirs in the basin. Both migrating and wintering populations use lowland streams, lakes, reservoirs, and wetlands for resting and feeding areas.



Young fisherman on one of the Willamette's tributaries.

The basic inputs of an area's economy are *RESOURCES*, *PEOPLE*, and *ENTERPRISE*.

It is the combination of these three inputs that gives the Willamette its unique character.





THE ECONOMY

Historically, the basin has been known as a commerce and transportation center and has been noted for products associated with its natural resources. The majority of its workers have been directly involved in producing, harvesting, or processing forest and agricultural products or providing goods and services to those that were. Its economy today is still resource-oriented, but there is a growing trend toward service and "foot-loose" manufacturing industries. The latter are not locationally tied to the area's natural resources, but rather are located in response to the area's amenities, to personal and family ties of their owners and managers, to living conditions, climate, space, market access, and availability of manpower.

Settlement in the basin can be traced in large part to its being a transportation hub and commercial center, and to production



and export of lumber, agricultural, and food products. Economic activities have been further shaped by the area's resources and locational advantages and by the inherent abilities of its residents. Land use patterns are due to such factors as ownership, soil productivity, vegetation, water, and physiography.

In 1965, there were 530,400 persons employed in the basin. One out of five was employed in the resource-based industries: forest products, agriculture, processed food products, mining, minerals, and related industries.

Several of the Nation's largest manufacturers of lumber, plywood, wood specialties, pulp, and paper are located in the basin. Industry output supplies a significant part of the Nation's forest product needs; its products are shipped to national and world markets.

About 30 percent of the basin area is in farms; agricultural production approximates \$180 million annually. There is also a major food processing industry with nearly 400 firms, its principal export products being canned and frozen fruits and vegetables.

Willamette Basin has other resource-based industries. It has a modest mineral industry, and it has rapidly expanding

primary metals and chemical industries. Expectations are favorable for continued increases in nonferrous and exotic metal products and industrial and farm chemicals.

The manufacturing base is becoming increasingly diversified. Many of the newer industries are experiencing the most rapid rates of growth. The more important categories are machinery, fabricated metals, electrical machinery, transportation equipment, printing and publishing, textiles, and apparel. Industries in this group are more dependent upon markets than upon resources. The development of a "balanced mix" of manufacturing industries, as is now occurring in the basin, is a characteristic of growing areas.

Also important to the basin's economy are its noncommodity-producing industries. These have markets throughout most of Oregon and southern Washington. Willamette Basin serves as a hub for many markets—retail trade; wholesale trade; construction; finance, insurance, and real estate; communications and public utilities; business, personal, and medical services; transportation; State and local government; and self-employed. These industries, in total, have been growing rapidly and will continue to be a major factor in the future of the basin's economy.

I N C O M E

Personal income is an important measure of the accomplishments of economic activity. Because it is a gauge of both economic activity and purchasing power, it is probably the most comprehensive measure for regional analysis. The basin's major sources of personal income are manufacturing, trade, government, and proprietary and property incomes.

Manufacturing—At \$488 million in 1960, this has been the most important single source of wage-and-salary income. Its proportional contribution to the basin's economy, however, is less than the national average.

Trade—With wage-and-salary income of \$411 million, wholesale and retail trade is second only to manufacturing in importance. Its industrial significance is evidenced by the fact that it is 21 percent above the national average.

Property Income—Income from property, more than \$363 million, is also important to the basin's economy. Property income has grown rapidly and coincides with the national average.

Proprietary Income—With a total of \$346 million, nonfarm proprietary income is well above the national average.

and is indicative of the basin's industrial composition.

Government—Wages and salaries paid by all levels of government totaled \$327 million. Payments in the basin to government employees have been growing rapidly; the proportion of income in this section is the same as for the nation.

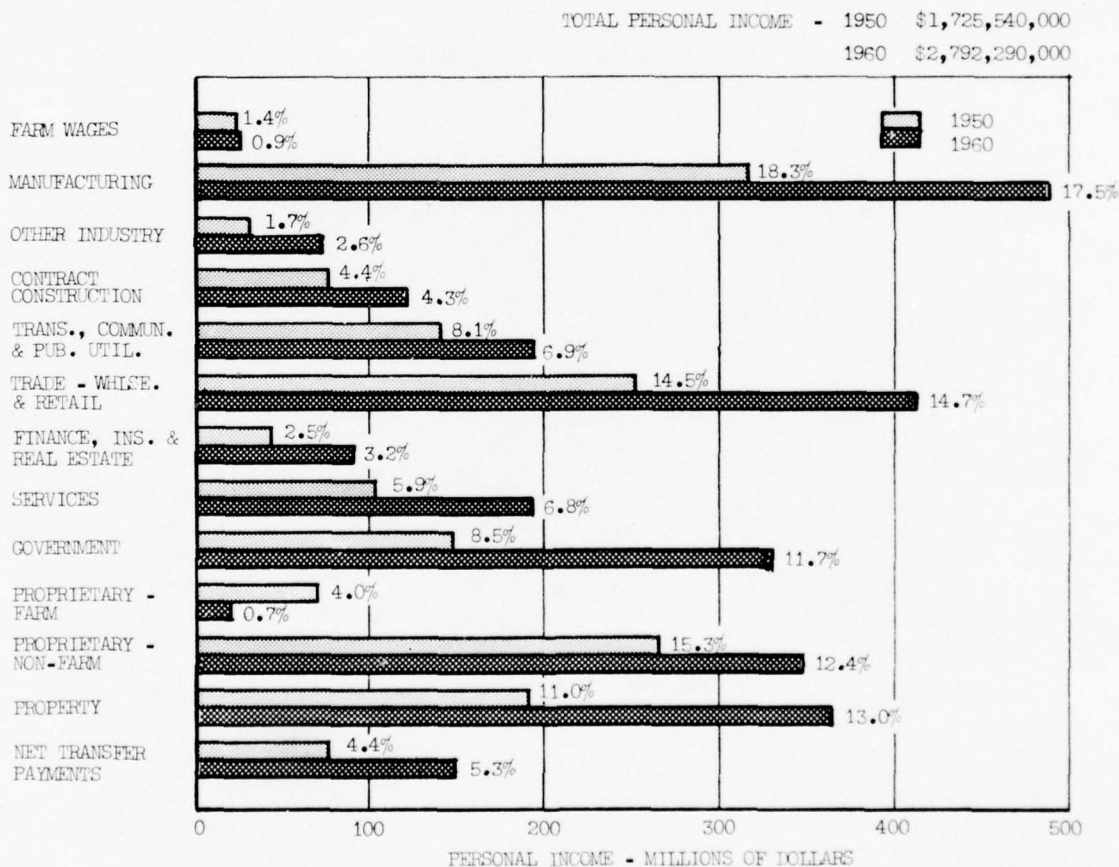
The several remaining sectors—services, transportation, communications, public utilities, contract construction, and net

transfer payments—account for \$650 million of wage and salary payments. Of these, services has been the most rapidly growing sector.

Per capita personal income in the basin exceeded the national average during the 1950-1961 period. In 1960-61, it was \$2,357, being 5 percent above the U.S. norm.

Total personal income in 1960 was \$2.8 billion. It is expected to more than double, to \$6.5 billion, by 1980 and to grow at similar rates through 2000 and 2020.

PERSONAL INCOME BY MAJOR SOURCES



EMPLOYMENT AND INDUSTRIES

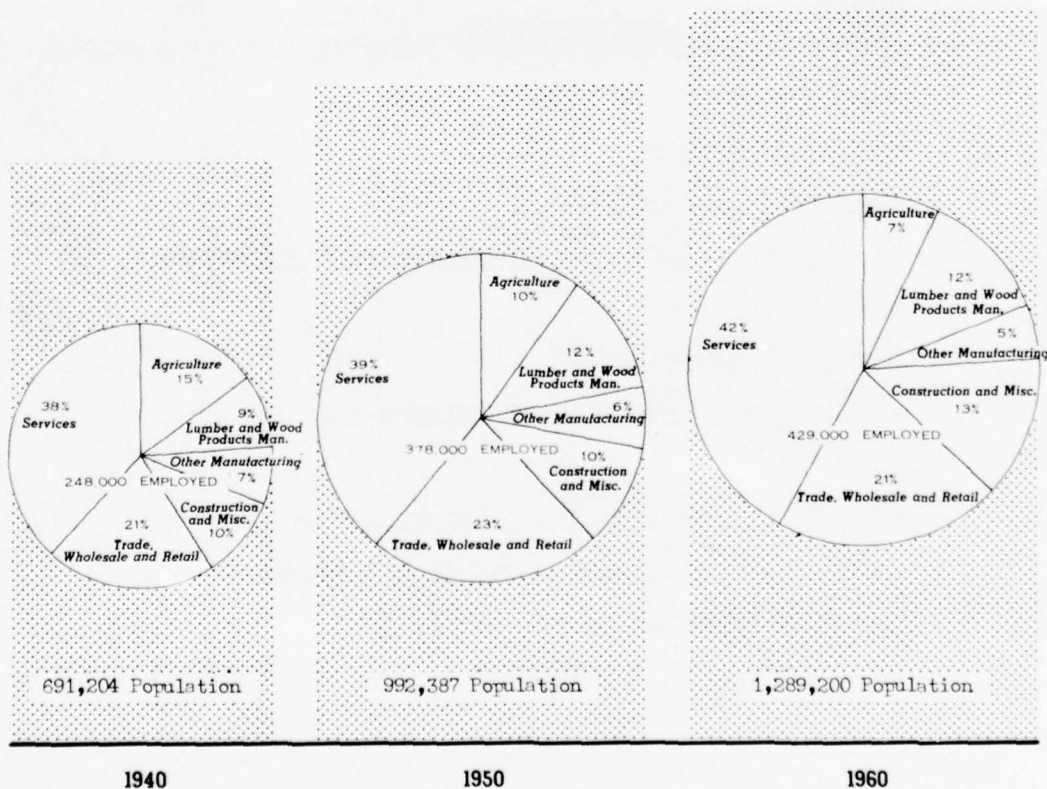
Employment data reflect industrial distribution, industrial growth, and change. In Willamette Basin, major economic changes are occurring in agriculture, services, and government; changes that are consistent with national trends. Agricultural employment is decreasing, while government and services employment is increasing.

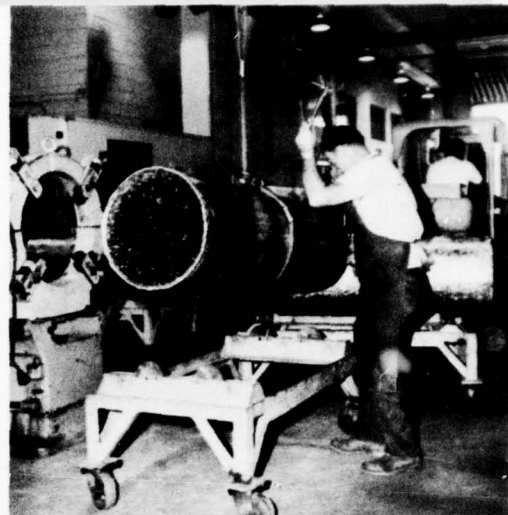
Employment was analyzed in each of the area's basic industries. These are the industries that provide goods and services for national and export markets; their markets are largely independent of the basin population. They are largely responsible for outside incomes and thus are essentially the primary force which sets the pace of economic growth.

Noncommodity-producing industries are those providing services primarily to residents, and to populations in adjacent areas. They serve mostly the local market and are, therefore, dependent primarily upon development and incomes from basic industries. However, they also serve populations and industries of adjacent areas; changes in these markets are also important to their expansion. Industries included in this category are: transportation, communications, and utilities; construction; retail trade; finance, insurance, and real estate; self-employed; and State and local government.

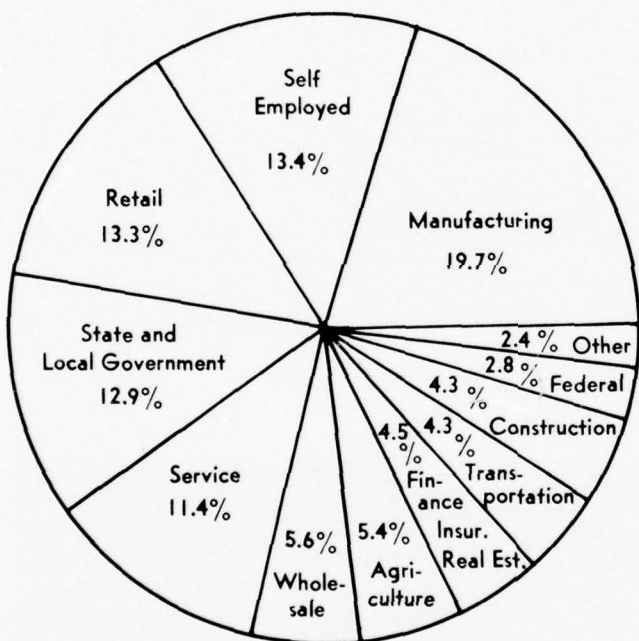
Several of the area's basic industries were analyzed individually.

EMPLOYMENT DISTRIBUTION

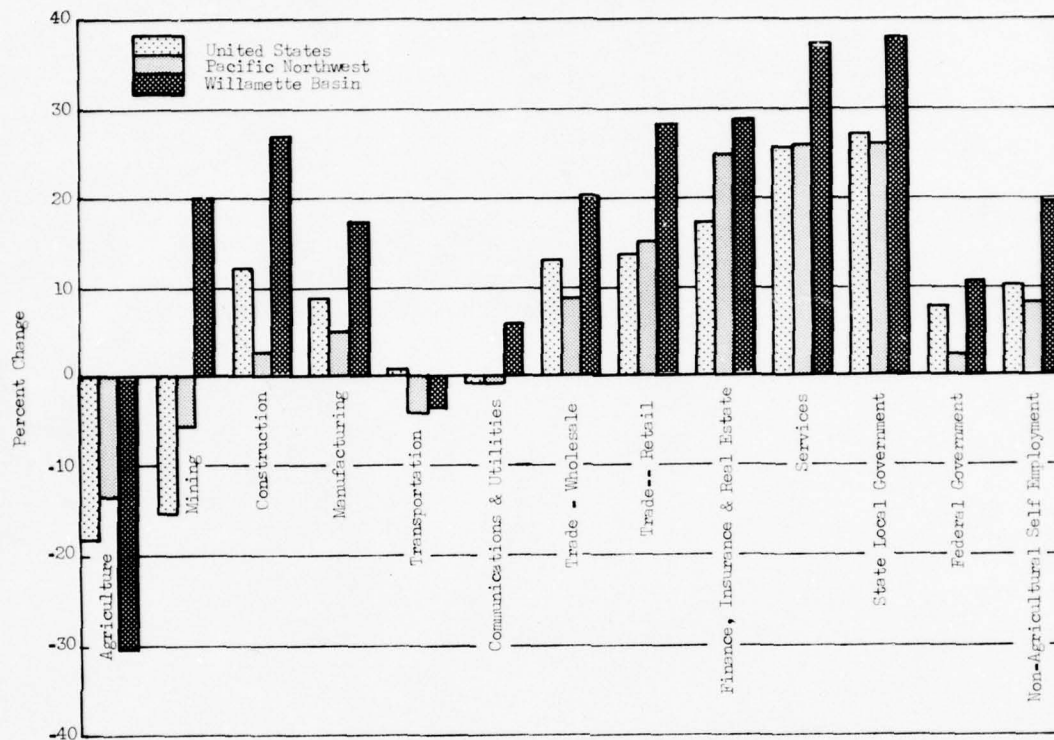




EMPLOYMENT 1965



PERCENTAGE CHANGES IN EMPLOYMENT 1958-1964



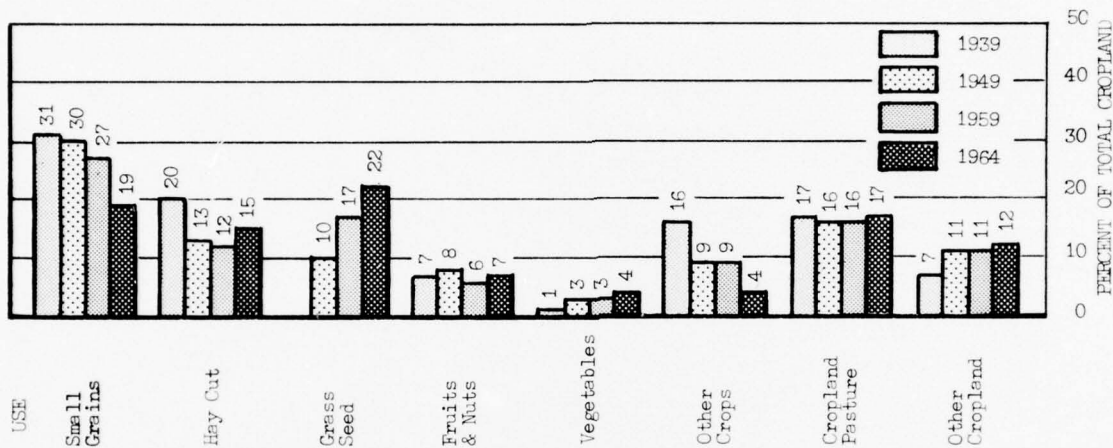
A manufacturing plant located along lower Willamette River.

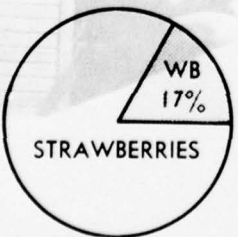
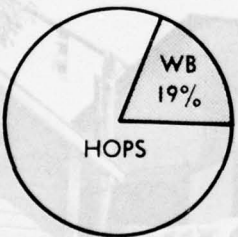
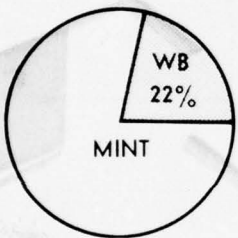
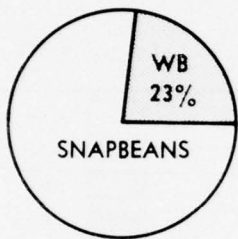
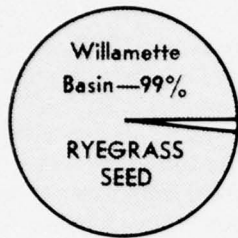
Agriculture

Employment in agriculture is expected to decrease; however, agricultural output is projected to increase substantially. Agricultural and cropping practices are expected to intensify. Sales to and purchases from other sectors of the economy

will continue to increase. In 1960, 33,440 persons were employed in agriculture, but by 1967 agricultural employment had declined to 29,150. This decline is expected to continue; by 1980, the total is expected to be 18,700 and by 2020 employment will be only 11,000, about one-third of the 1960 level.

DISTRIBUTION OF CROPLAND





AGRICULTURAL OUTPUT
PERCENT OF TOTAL
UNITED STATES PRODUCTION 1959

Mining

Employment in the extractive phase of the mineral industry is minor and is expected to remain so. The number employed is expected to increase gradually from 890 in 1965 to approximately 1,000 by 2020. Increases in output will be considerably greater than the increases in employment.

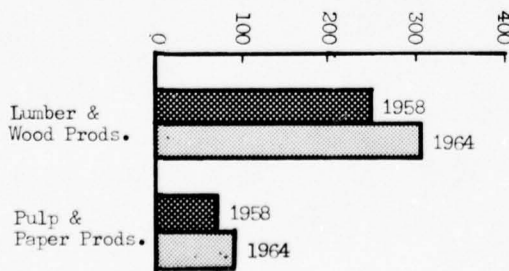
Manufacturing

Total manufacturing employment is projected to increase a nominal 12 percent from 1965 to 1980 and thereafter increase more rapidly. A slower rate of employment increase to 1980 is anticipated because the basin has a large number of manufacturing industries that are presently declining in employment. In 1965, two manufacturing categories—lumber and wood products and food products—accounted for almost one-half of total manufacturing employment. As these “slow growth” industries become a smaller proportion of the manufacturing base, their influence on total manufacturing employment will lessen.

By 2020, the number employed in manufacturing is projected to reach 250,350, an increase of almost 150 percent over the 104,470 employed in 1965. A brief summary of projected employment trends in the major categories of manufacturing follows.

VALUE ADDED BY MANUFACTURE

MILLIONS OF DOLLARS

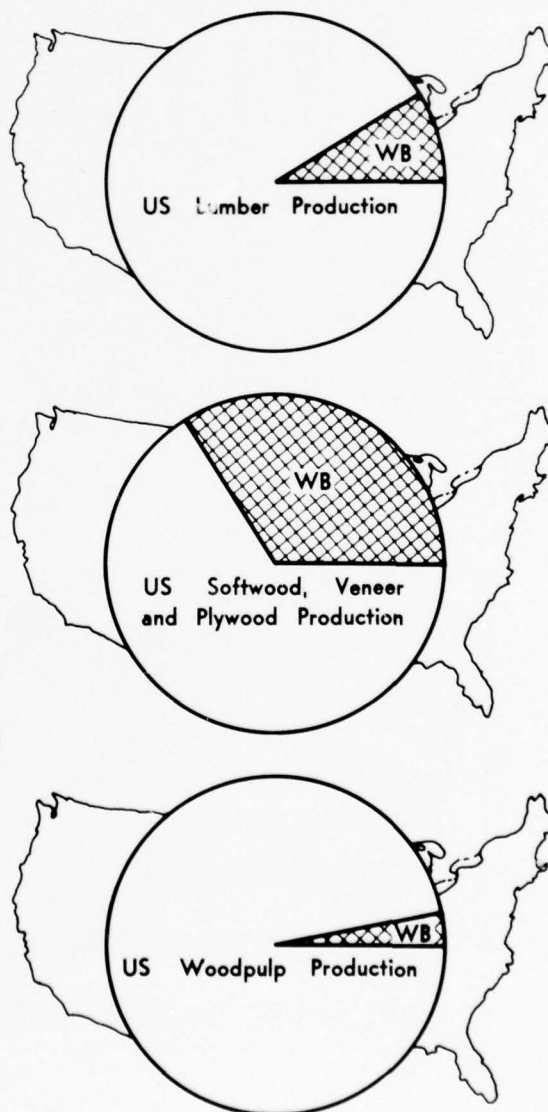


Lumber and Wood Products

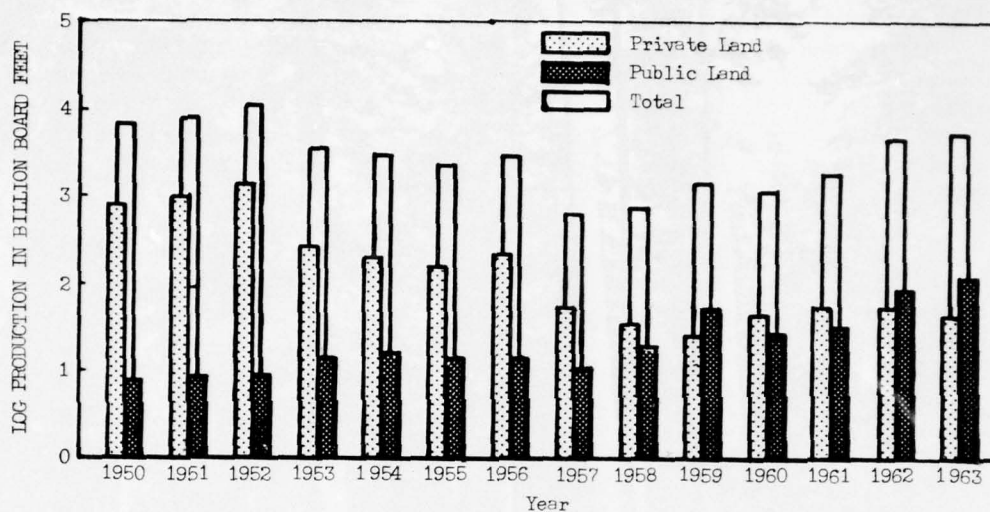
Employment in the manufacture of lumber, plywood, particle board, and other wood products totaled 34,550, or one-third

of the total manufacturing employment in 1965. It is the principal manufacturing industry in the basin. Significant shifts in the product mix and increases in labor productivity are expected to result in reduced employment in the future. Employment is projected to decrease to 27,550 in 1980 and decline further to 18,850 by 2020.

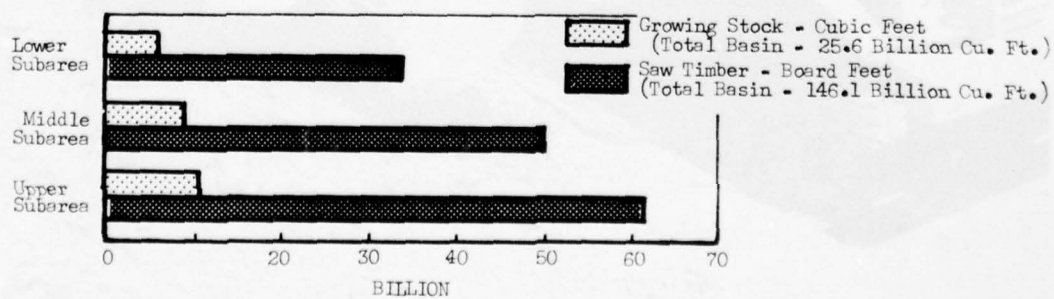
SHARES OF UNITED STATES MARKETS 1963



ANNUAL LOG PRODUCTION 1950-1963



VOLUME OF GROWING STOCK AND SAW TIMBER 1963



Food and Kindred Products

Food processing is the second largest manufacturing industry in Willamette Basin. In 1965, the industry employed 14,760, representing 14 percent of the total in manufacturing. The number employed is expected to decline steadily during the study period; productivity per worker will increase faster than output, thereby reducing overall employment. Employment is expected to be approximately 12,600 by 1980 and to decline slowly to 11,700 by 2020.

Paper and Allied Products

The number employed in the production of pulp and paper products is estimated to increase from 5,370 in 1965 to 5,500 in 1980. Anticipated advances in technology will thereafter decrease employment to approximately 4,400 by 2020. Production is projected to increase during the next two decades and remain essentially unchanged after the 1980's.

Chemical and Allied Products

The rate of increase in output of chemical products in the basin has exceeded that of the Nation during the last 10-year period. This is one of the basin's important growth industries. With the addition of new plants and the expansion of existing plants, its accelerated rate of increase is expected to continue as the basin supplies a greater portion of the region's demand. Employment is estimated to increase from 1,833 in 1965 to 2,200 in 1980. The number of workers is projected to reach 5,100 by 2020. Output by 2020 is estimated to be approximately 10 times greater than it was in 1963.

Primary Metals

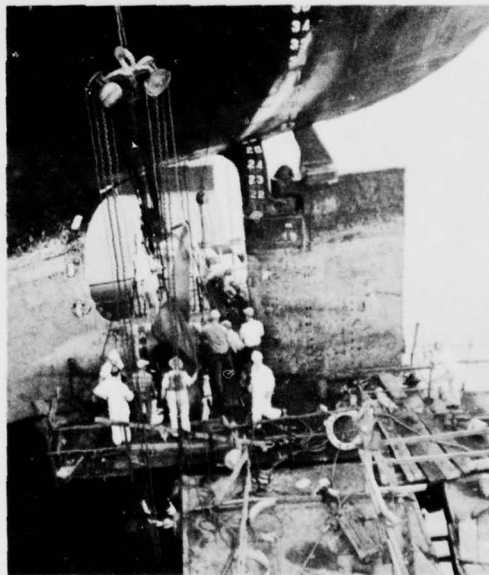
Employment in all categories of primary metals is expected to increase steadily from 5,220 in 1965 to 12,300 by 2020. Production of ferrous metals will increase to meet rising local and regional demands. There is

an important nonferrous metals complex in the basin. A large part of that output—aluminum and "exotic" metals—will continue to flow to national markets.

"All Other" Manufacturing

Diversification of the area's manufacturing base is increasing rapidly. Many manufacturing industries in this group have experienced the greatest growth. Among these industries are electrical machinery, transportation equipment, machinery, fabricated metals, textiles, apparel, and professional instruments. These industries have responded to rapid increases in industrial markets. One firm, an electronics manufacturing concern located near Portland, serves national and international markets and is the largest private employer in the basin.

Firms and industries of this group now serve regional, national, and international markets for capital goods, for consumption, and for remanufacturing. In recent years, shares of these markets have increased steadily. These trends are expected to continue; both output and employment in these categories are expected to increase significantly.



Shipbuilding and repair facilities in the Portland area.

Federal Government

Federal employment totaled 14,040 in 1965 and has been increasing at a rate less than that of total employment. This trend is expected to continue in the future. Total Federal employment in the basin is expected to reach 17,000 by 1980 and approximately 24,000 by 2020.

Noncommodity-Producing Industries

In addition to the Willamette's basic industries, this group of industries comprises the balance of the total economy. This is an important group and it includes several of the basin's most rapidly growing

industrial classifications. Included in this category are construction, transportation, utilities, trade, finance, insurance, real estate, miscellaneous services, self-employed, and local and State government.

Outputs of the noncommodity-producing industries have been increasing rapidly. Employment in this group increased from 314,500 in 1960 to 383,800 in 1965. Employment resulting directly from recreation and tourism is reflected in this classification. These industries will continue to be a major factor in future expansion of the basin's economy. By 1980, the number employed is projected to approach 500,000 and by 2020 employment is projected to exceed 1,000,000.

THE FUTURE

Continued economic expansion will take place in Willamette Basin. The basin will have a new economic profile in each decade. The proportion of persons employed in resource-based industries will decline from about 20 percent in 1965 to 11-1/2 percent by 1980 and will decline further to 7-1/2 percent by 2000. The manufacturing base will continue to diversify, especially in the metals-working industries. Firms in those industries will be technologically oriented. Service industries will continue their expansion, and expenditures for recreation and tourism will become increasingly important.

Natural resources and resource-based industries will still be important to both the basin's environment and its economy. Forests will still dominate the mountainous areas. By 2020, the annual log harvest will decline to about 82 percent of the 1963 level, but improved forest practices, including more intensive silvicultural techniques in many areas, will enhance the natural environment. The basin's forest product industries will continue to supply national and world markets.

Of the 4-1/2 million acres of agricultural lands in 1960, 2.8 million acres were suitable for cultivation. By 2020, total

agricultural lands will decline to about 3-3/4 million acres while cultivable lands will decline to about 2.4 million acres.



Industries are becoming more diversified with less emphasis on indigenous resources.

Thus, a collage of farm lands will still dominate valley-floor and foothill landscapes. These broad open spaces, sometimes interlaced with suburban areas, will be important to the future basin environment. Even though the acreage in agriculture will have declined, the value of agricultural output will increase about 2-1/2 times by 2020.

Willamette Basin has a pleasant climate, an attractive environment, and an interesting culture. Also, it has an adequate inventory of resources to facilitate future development—including mineral resources, power supply, water supply, low climatic fuel needs, good forest and agricultural production capacity, a good transportation system, access to markets, and many public facilities. Willamette Basin will continue to

be one of the Pacific Northwest's growth areas.

In economic terms, the Willamette Basin economy of the future will have:

1. Increased production and income—Total output will increase significantly, as will production per employee. Total personal income will increase from \$2,792,000,000 in 1960-61 to \$31,240,000,000 by 2020.

2. More jobs—Employment will increase from 530,430 in 1965 to more than 1,300,000 by 2020.

3. An increased population—Increasing job opportunities, an attractive climate, a unique and developed culture, and significant amounts of private and public capital in combination will cause Willamette Basin to grow more rapidly than national norms.



Just upstream from where Willamette River joins the Columbia is the Port and City of Portland - hub of the basin's population, its financial and industrial center and its gateway to world trade.

The challenge of our age is whether we shall seize the opportunity to decide what kind of life, what kind of environment, and what kind of opportunities we want for ourselves and for our children.

Senator Henry M. Jackson





THE HUMAN RESOURCE

Our complexity as individuals, the ease with which we move throughout the country, and the equalizing effect of mass communication all tend to obscure regional characteristics. Still, the effects of early background and influences continue to be important in Willamette Valley development, character, and attitudes.

The steady though conservative econ-

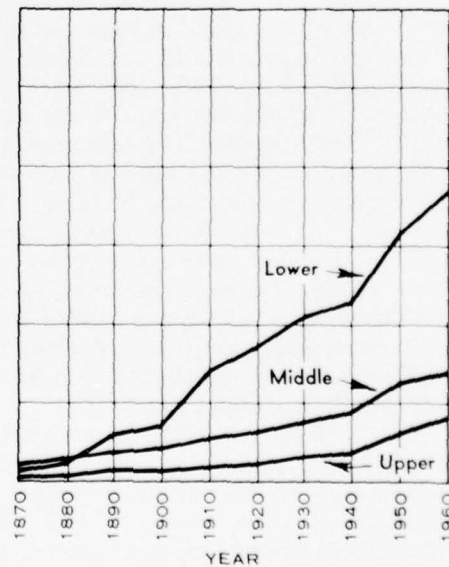
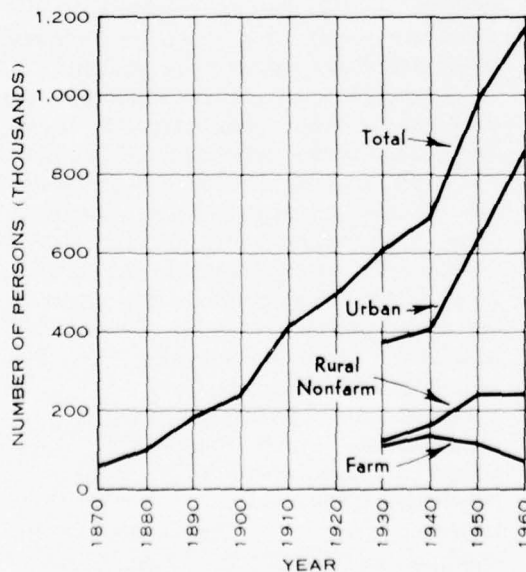
omic growth of the basin, the lack of pressure of population which characterize many eastern areas, the lasting effects of a recent pioneer past, the continuing reliance on natural resources for livelihood—all have tended to produce and attract people who are basically conservative, independent, and outdoor oriented.

PRESENT POPULATION

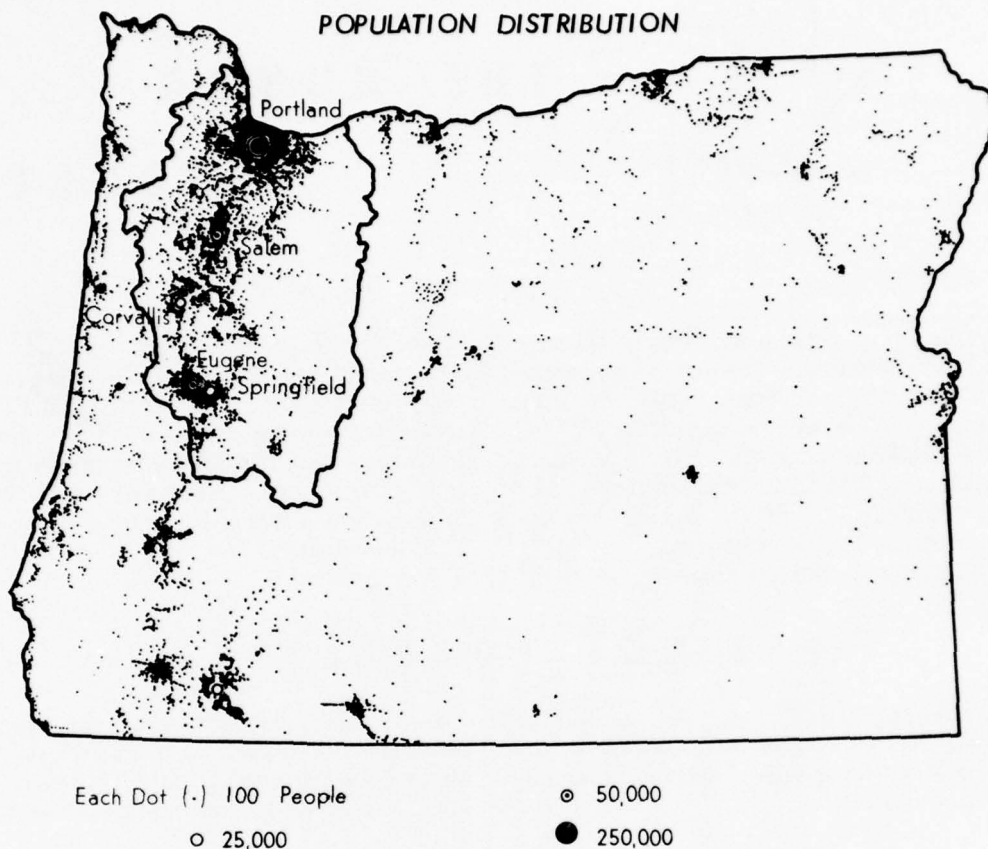
The population was 1.34 million in 1965. Over 68 percent of the population of the State of Oregon lived within the boundaries of this basin.

The 1965 population of the Upper Subarea was 198,000, an overall density of 50 persons per square mile. However, almost two-thirds of the population of this

POPULATION TRENDS



POPULATION DISTRIBUTION



area was concentrated around the Eugene-Springfield area where density of the urban area was about 3,000 persons per square mile. The population of the Middle Subarea, 329,900 in 1965, has an average density of about 60 persons per square mile. About one-fourth of that population lived in Salem and the adjacent unincorporated suburban fringe area. Population density of urban areas in the Middle Subarea was about 2,600 persons per square mile. The Lower Subarea, the most densely populated area in Oregon, had 811,000 residents in 1965, about half of whom lived in Portland. The population density was 300 persons per square mile.

In all, 73 percent of the basin's residents live in urban areas. There are 82 incorporated cities in the basin. Portland, the largest, had a population of 382,000 in 1965, while the smallest incorporated community, Barlow in Clackamas County, had

a population of 98. The remaining 27 percent of the basin's residents live in nonurban areas: 21 percent are nonfarm, while only 6 percent are farm residents.

Among the smaller cities, some have lost population within their corporate limits, while some others have had rapid increases. Those cities, having a population loss generally are smaller centers located in the fringe areas of the valley where there has been a traditionally rural economic orientation. Many of the fringe cities are dependent on the forest products industry. Several rural agricultural communities also have lost population. Nevertheless, there seems to be a stabilization of population in contrast to the decrease which characterized these fringe communities during the decade of the fifties. Most of them have had slight increases since the 1960 census. Some communities adjacent to the major metropolitan cities have had rapid increases.

The density of population is important to water resource planning and development, particularly to flood control, water supply, waste disposal, and recreation. Projections indicate that areas which at present have the greatest densities will in the future grow faster than surrounding areas. Thus, problems relating to population density will be most acute in the Lower Subarea, in the Salem portion of the Middle Subarea, and in the Eugene-Springfield portion of

the Upper Subarea.

A significant characteristic of the basin population is its rate of growth in comparison to the past and to other areas. Willamette Basin has long been, and is expected to continue to be, one of the Nation's growth areas. Since 1910, the average rate of basin population increase has equaled or exceeded that of both the Pacific Northwest and the Nation.

POPULATION PROJECTIONS

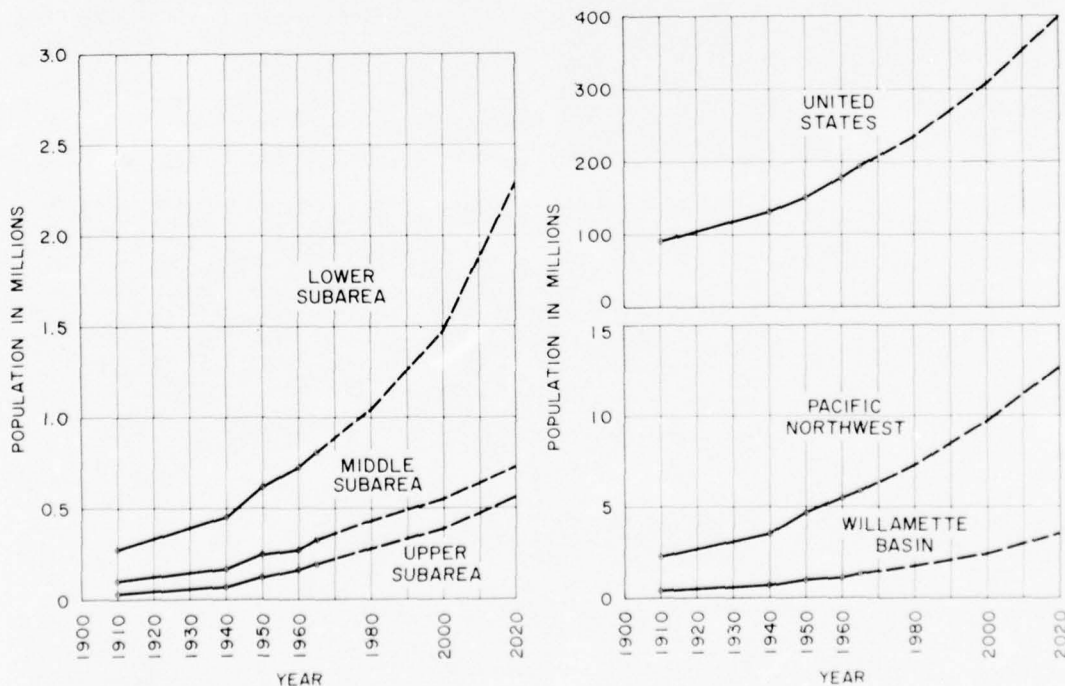
Future populations were estimated by projecting the future employment of certain "base" industries (agriculture, forestry, mining, manufacturing, and government), assuming ratios of employment in base industries to employment in nonbase industries, and finally by assuming ratios of total population to employed population.

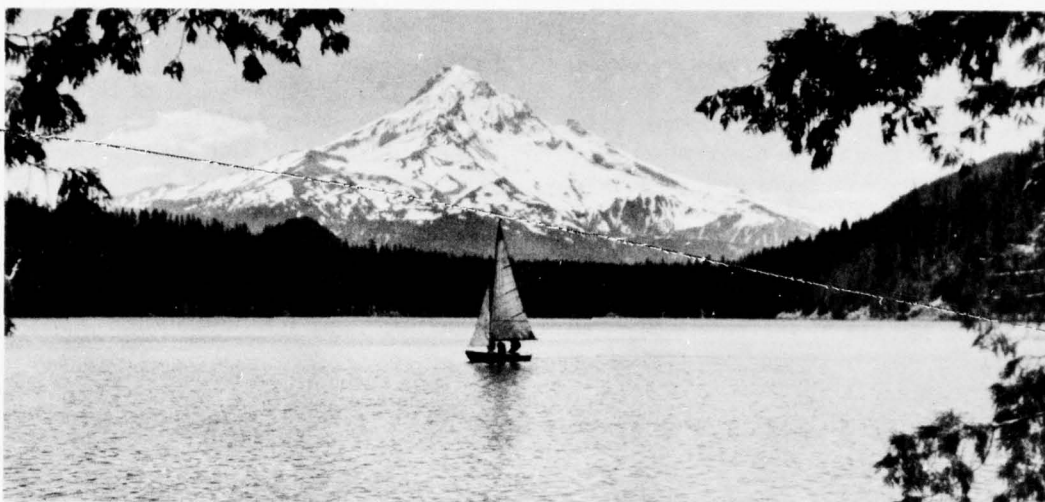
The population of the basin, estimated at 1,338,900 in 1965, is projected to

increase to 1,767,500; 2,422,000; and 3,591,000 by 1980, 2000, and 2020, respectively. The population projections, by subarea are graphically shown below.

Thus, for every person now living in Willamette Basin, the turn of the century will see two people and by 2020 there will be three. It is this assumption that lies behind nearly all of the needs for water resource and environmental planning.

POPULATION PROJECTIONS







QUALITY OF LIFE

Man's history is one of continuing effort to improve or maintain the quality of his life. This has not been a straight march toward a clear goal. Each person has his own definition of the good life. Thus, an evaluation of the quality of life in Willamette Basin is not an absolute but an opinion; an opinion held by the people who have lived and now live here. Opinions as to the quality of life understandably vary depending on the circumstances of the individual. There is no desirable place in which to live in poverty. And, in common with other areas, Willamette Basin has people both in urban and rural areas who do not view their surroundings in terms of quality or opportunity. At the other end of the economic scale are people who may with relative ease leave the basin in pursuit of whatever elements of the good life they feel are not available here. Neither of the two groups provides the basis for a consensus on the basin's livability. Rather, it is the broad middle segment of the basin's residents who answer the question: does the basin's environment provide for the good life?

The number of people moving into Willamette Basin, the tendency for people to remain, and the frequency of people returning because "it's a good place to live," all provide some basis for finding a consensus regarding the quality of life.

Nature gave Willamette Basin a good start as far as a livable environment is concerned: landforms that vary from Cascade peaks to valley grasslands to Coast Range foothills; timber stands covering nearly two-thirds of the land; watercourses from mountain streams to major water-

ways; a variable but moderate climate; and a variety and abundance of fish and wildlife.

A relatively small concentrated population in relation to the total basin area (1.34 million people, 12,045 square miles) means that basin residents seldom are far from open agricultural land, forest lands, rivers or other open space where men may contact earth and sky instead of concrete and steel. It has been said that man lives in two environments—the natural world, and the world of his own making. Perhaps the most salient fact about the basin's environment is that what man has built here has not yet blotted out what nature has given.

According to projections, the population of the basin will triple in the next 50



Tamolitch Falls on McKenzie River

years. This will result in at least a proportional increase in demand for homes, freeways, industries, airports, schools, recreation areas, and all the other space-using demands of people.

Present development is concentrated along a narrow strip bordering Willamette River from Eugene to Portland; projections indicate that the future will see a strip-city or urbanized corridor from one end of the valley to the other. As urban centers merge into adjacent urban centers, the basin's open space will become more valuable as a natural resource. There is growing evidence that the key to physical survival of a people or a region is the survival of the spirit, and that survival of the spirit depends to a great extent on man's recognition of his relationship to his total environment. Space may well be the basin's most important natural resource.

In 1960, urban and built-up land uses totaled almost one-third of a million acres, and these uses are projected to increase to more than one-half million acres by 1980 and well over a million acres by 2020. Willamette Basin, which depends heavily on the natural environment and open space for its livability, will necessarily undergo considerable change. As urbanization of the basin continues, there will be an increase in the use of remaining open space. "Getting

away from it all" will become increasingly difficult because of more and more people in less and less space. There are at least two likely results of this diminishing space-increasing population cycle. First, people will be willing to pay more for relative solitude, which will continue to foster private development in quality living. There will be strong pressure to develop private lands where livability in terms of people-space can be controlled. Second, there will likely be government and private effort to incorporate more livability into areas being urbanized and built-up. If the Willamette Basin is to remain a quality place to live, it will require a recognition of the relationship between quality of environment and quality of life by each segment of the basin community.

The quality of environment can be maintained or enhanced at the neighborhood level, at the city level, at the metropolitan region level, and basinwide. Each proposal or development to meet future basin needs must be considered not only as to the effect which that development would have on the livability of the area affected, but further as to what opportunities may be available to enhance the quality of people's lives through development.

Water may be pleasant to look upon, to walk beside, to contemplate. It may provide a variety of active recreation experiences. It may enhance the visual scene wherever it appears--in cities or in wilderness. It may enhance values of adjoining properties--public and private. It may be a focal point of pride in any community.

A National Technical Advisory Committee on Water Quality



1900 Power. ▢

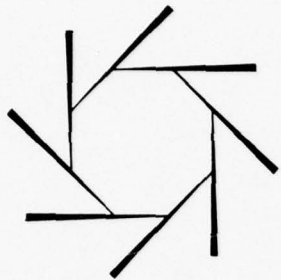


1940 Flood control - navigation - irrigation. ▢



1968 Flood control - navigation - irrigation - power. ▢





PRESENT RESOURCE USE AND DEVELOPMENT

Development and use of the basin's water resources began in 1838 with the construction of a water wheel at Willamette Falls. Since then, there has been a conservative but steady increase in development; an increase which has paralleled the conserva-

tive but steady economic growth of the basin. Most of the improvements prior to 1940 were single-purpose in nature—municipal water supplies, individual irrigation systems, industrial water supplies, power developments, and navigational improvements.

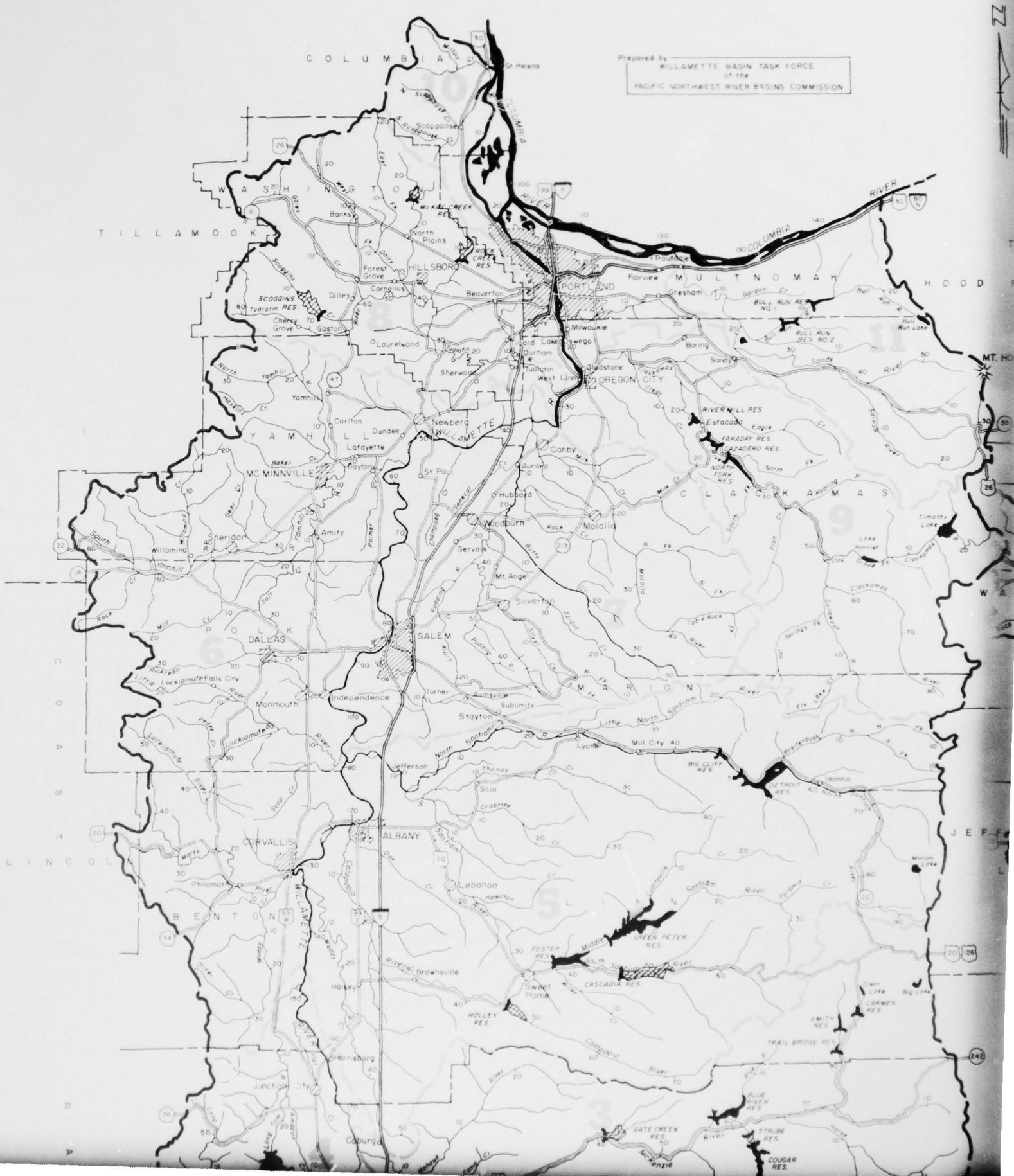
STORAGE DEVELOPMENT

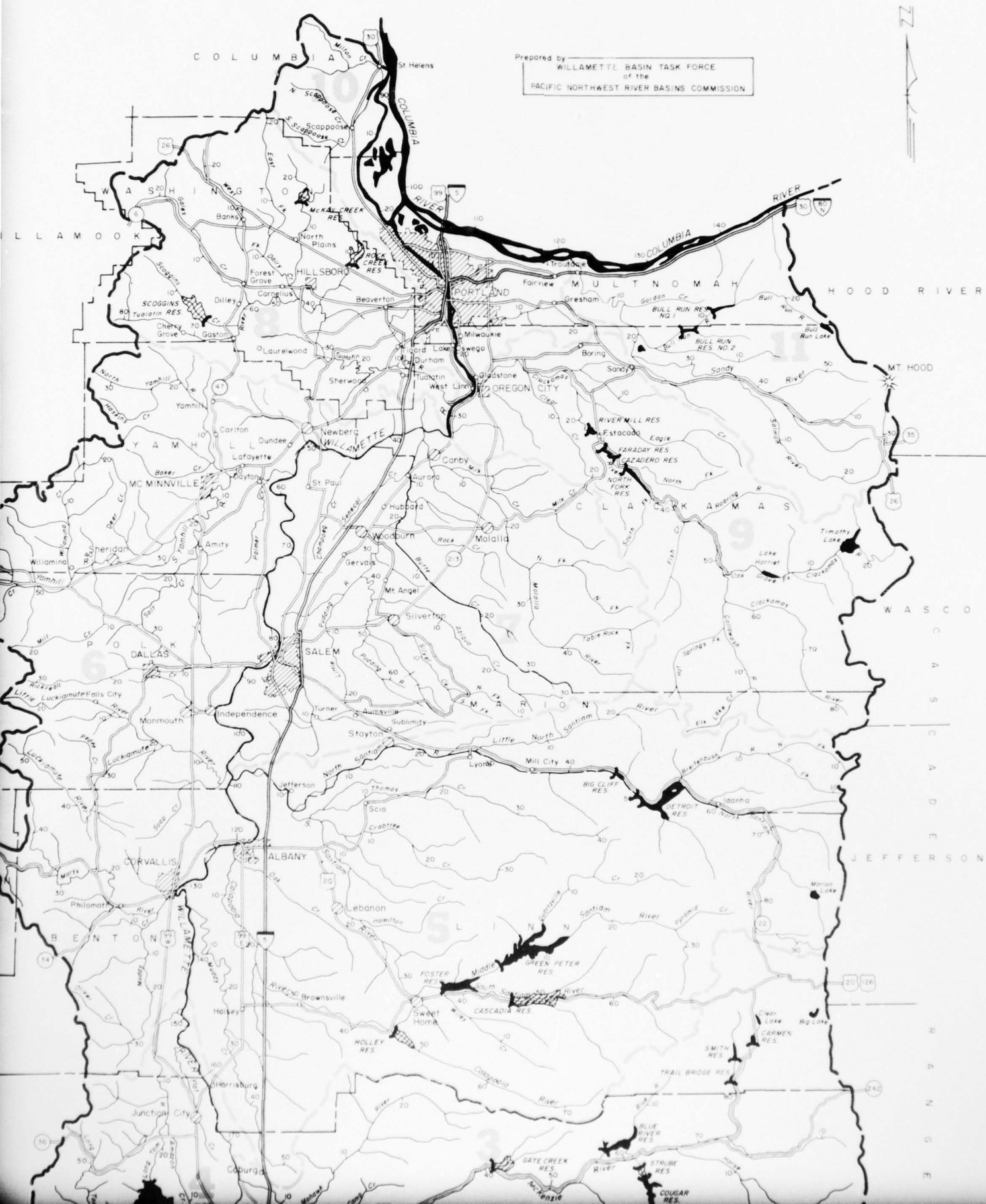
The construction of Fern Ridge Reservoir near Eugene in the early 1940's began the era of multiple-use development. A plan of considerable foresight to provide flood control, irrigation, power, and navigation flows through storage on the major tributaries of Willamette River was conceived in the early 1930's. Fern Ridge was the first element of that plan. Other elements have since been constructed and the basic Willamette storage system now con-

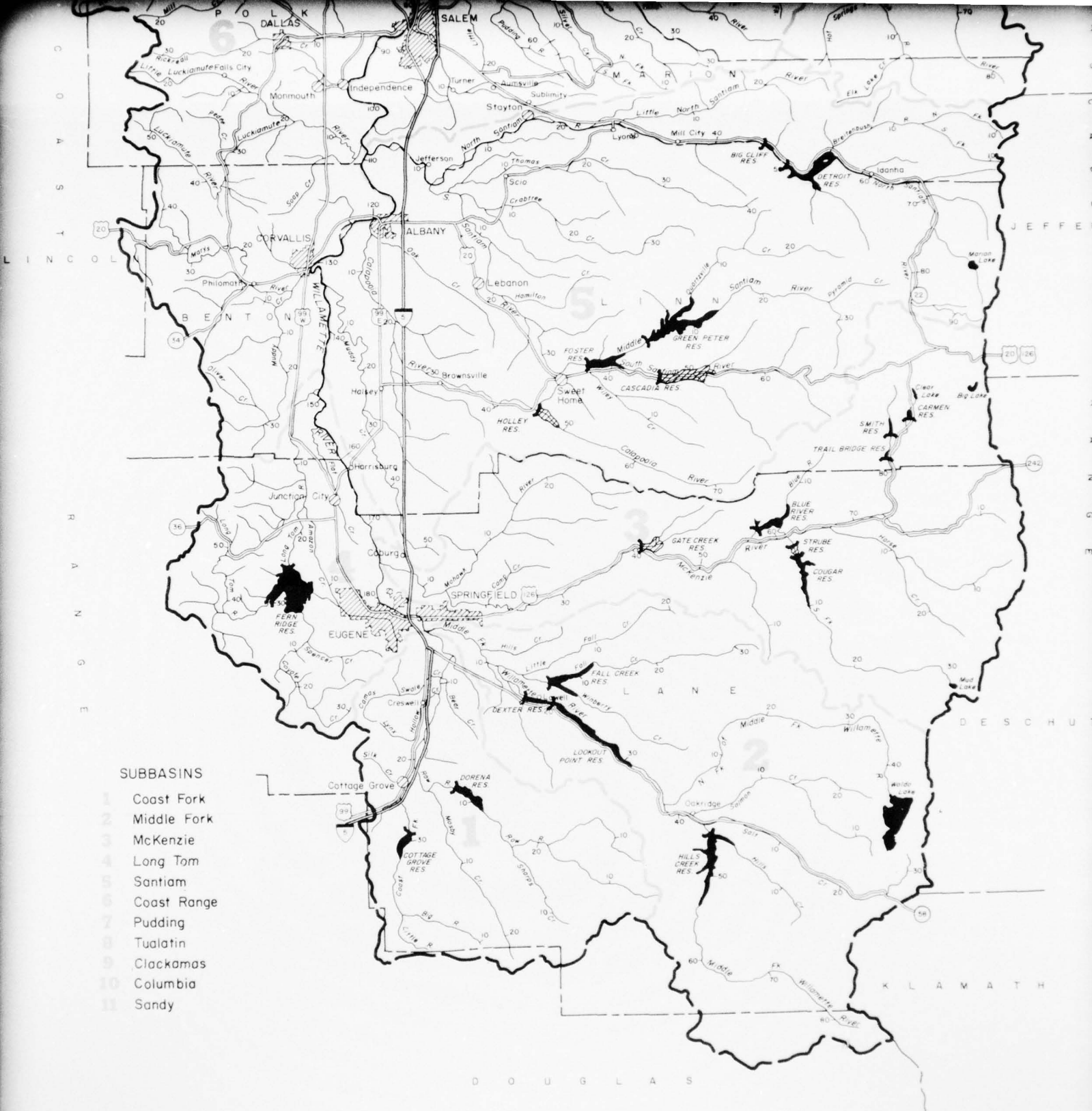
sists of 13 reservoirs. In addition, there are several private industrial and power storage reservoirs. Map 1 shows the location of those reservoirs. The table on the following page lists basin reservoirs with more than 300 acre-feet of usable storage; the table includes several reservoirs which are authorized but as yet not operational. In all, the basin's reservoirs have a total of about 2,409,000 acre-feet of usable storage.

Existing, authorized, and planned Willamette Basin
reservoirs with 300 acre-feet or more of usable
storage capacity

Subbasin and Reservoir	Stream Name	Usable Capacity Ac.-ft.	Installed Gen. Cap. KW	Auth. Purpose or Use 1/	Subbasin and Reservoir	Stream Name	Usable Capacity Ac.-ft.	Installed Gen. Cap. KW	Auth. Purpose or Use 1/
<u>Coast Fork:</u>					<u>Coast Range:</u>				
Cottage Grove	Coast Fk.	30,000	-	FC,N,I	Haskins Cr.	Haskins Cr.	410	-	M&I
Dorena	Row R.	70,500	-	FC,N,I	N. Fk. Rock Cr.	N. Fk. Rock Cr.	307	-	M&I
Subtotals		100,500			Bark Cr.	Bark Cr.	362	-	R
					Clemens 2/	-	800	-	Indust.
<u>Middle Fork:</u>					Dallas 2/	Rickreall Cr.	1,200	-	M&I
Lookout Point	Middle Fk.	349,000	120,000	FC,N,I,P	Subtotals		3,079	-	
Dexter (Rereg.)	Middle Fk.	4,800	15,000	P					
Hills Creek	Middle Fk.	249,000	30,000	FC,N,I,P	<u>Pudding:</u>				
Fall Creek	Fall Cr.	115,000	-	FC,N,I	NONE	NONE			
Oak Ridge	-	380	-	Indust.	<u>Tualatin:</u>				
millpond 2/	-				Scoggins 3/	Scoggins Cr.	53,000	-	FC,I,M&I,R, F&W,WOC
Subtotals		718,180	165,000		McKay Cr. 4/	McKay Cr.	19,300	-	FC,I,M&I,R,F&W
					Rock Cr. 4/	Rock Cr.	3,800	-	FC,I,M&I,R,F&W
<u>McKenzie:</u>					Subtotals		76,100		
Cougar	S. Fk. McKenzie R.	165,000	25,000	FC,N,I,P					
Strube (Rereg.) 3/	S. Fk. McKenzie R.	3,000	39,500	P	<u>Clackamas:</u>				
Blue River	Blue River	85,000	-	FC,N,I	Timothy Lake 2/	Oak Grove Fk.	61,650	-	P,R
Gate Creek 3/	Gate Creek	50,000	-	FC,N,I	Oak Grove Fk.	Oak Grove Fk.	546	51,000	P
Weyerhaeuser 2/	-	420	-	Indust.	Clackamas R.	Clackamas R.	6,000	38,400	P,R
Walterville 2/	McKenzie R.	345	8,000	P	North Fork 2/	-	550	34,450	P
Trail Bridge 2/	McKenzie R.	2,750	10,000	P	Faraday Lake 2/	Clackamas R.	770	19,050	P
Carmen 2/	McKenzie R.	300	80,000	P	River Mill 2/	-	69,516	142,900	
Smith 2/	Smith R.	9,900	-	P	Subtotals				
Subtotals		316,715	162,500						
<u>Long Tom:</u>					<u>Columbia:</u>				
Fern Ridge	Long Tom R.	109,000	-	FC,N,I	Lake Oswego 2/	-	5,100 5/	522	P,R
Carroll 2/	Noti Cr.	355	-	I					
Subtotals		109,355			<u>Sandy:</u>				
					Trillium Lake 2/	Mud Cr.	353	-	R
<u>Santiam:</u>					Bull Run Lake 2/	Bull Run R.	12,300	-	M&I
Detroit	N. Santiam R.	340,000	100,000	FC,N,I,P	Bull Run No. 1 2/	Bull Run R.	30,100	-	M&I
Big Cliff (Rereg.)	N. Santiam R.	2,400	18,000	P	Bull Run No. 2 2/	Bull Run R.	21,000	-	M&I
Green Peter	M. Santiam R.	333,000	80,000	FC,N,I,P	Roslyn Lake 2/	-	970	21,000	P
Foster	S. Santiam R.	33,600	20,000	FC,P	Subtotals		1,030	21,000	M&I
Cascadia 3/	S. Santiam R.	145,000	-	FC,N,I					
Holley 3/	Calapooia R.	90,000	-	FC,N,I	<u>Willamette Basin Totals</u>		2,408,973	709,922	
Will. Nat. Lumber (Wiley Cr.	375	-	Indust.	1/ FC, flood control; N, navigation; I, irrigation; P, power; R, rearea-				
Company 2/	-	300	-	Indust.	tion; M&I, municipal and industrial; F&W, fish and wildlife; WOC, water quality control. All existing Federal reservoirs are used for				
Subtotals		944,675	218,000		recreation, even though not so authorized.				
					2/ Non-Federal development.				
					3/ Authorized Federal project.				
					4/ Being studied under separate authorization; considered to be part				
					of base system.				
					5/ Water diverted from out-of-subbasin Tualatin River.				

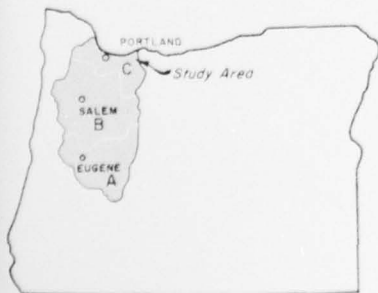






SUBBASINS

- 1 Coast Fork
- 2 Middle Fork
- 3 McKenzie
- 4 Long Tom
- 5 Santiam
- 6 Coast Range
- 7 Pudding
- 8 Tualatin
- 9 Clackamas
- 10 Columbia
- 11 Sandy



NOTE: RESERVOIRS SHOWN HAVE A USABLE STORAGE CAPACITY OF 1,000 ACRE-FOOT OR MORE.

EXISTING RESERVOIR
ASSURED RESERVOIR



MAP 1
WILLAMETTE BASIN STUDY
OREGON

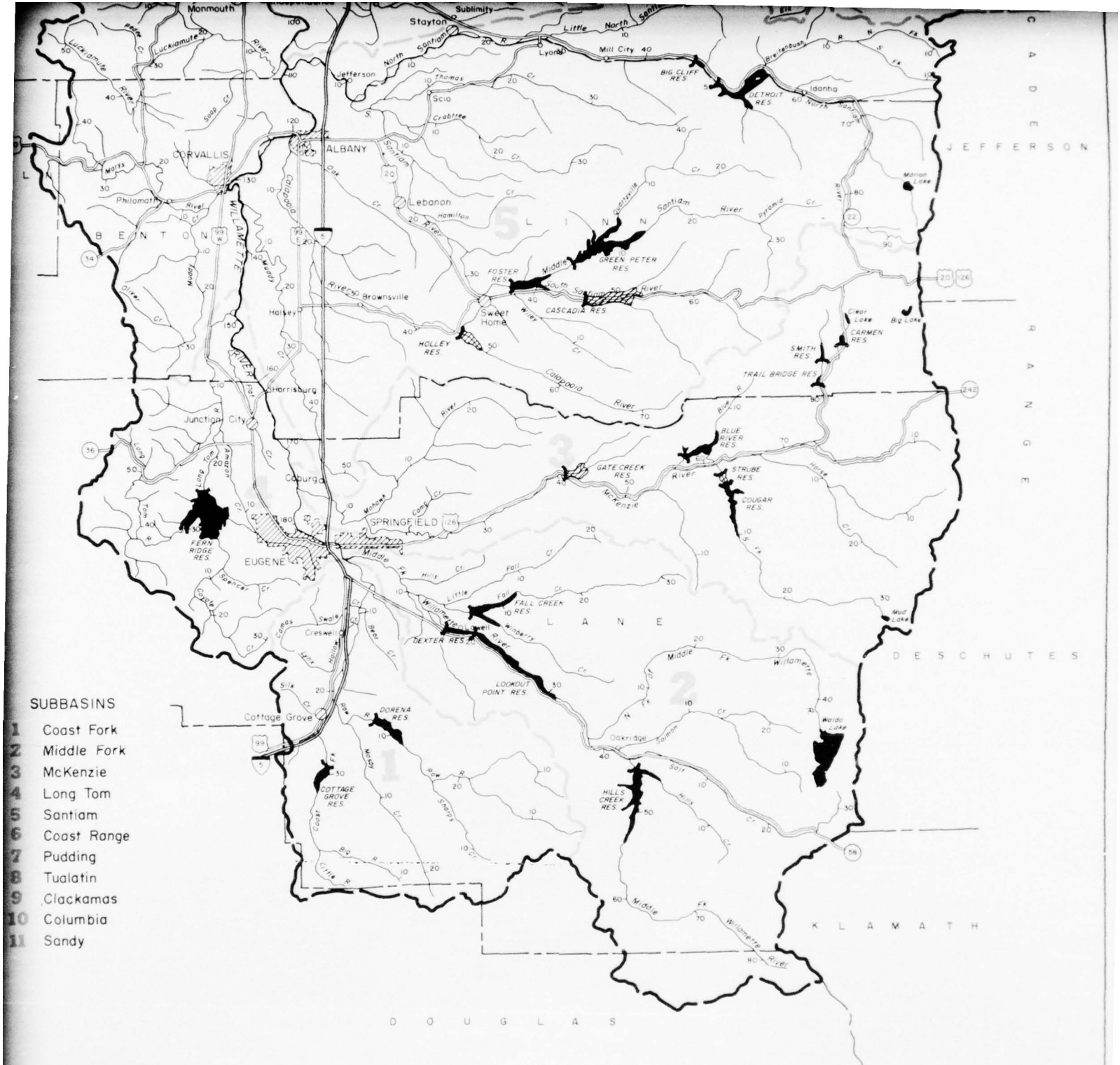
EXISTING AND ASSURED
PROJECTS

1969



SUBAREAS



A Upper



SUBBASINS

- 1 Coast Fork
- 2 Middle Fork
- 3 McKenzie
- 4 Long Tom
- 5 Santiam
- 6 Coast Range
- 7 Pudding
- 8 Tualatin
- 9 Clackamas
- 10 Columbia
- 11 Sandy

NOTE: RESERVOIRS SHOWN HAVE A USABLE STORAGE CAPACITY OF 1,000 ACRE-FEET OR MORE.

EXISTING RESERVOIR 
 ASSURED RESERVOIR 

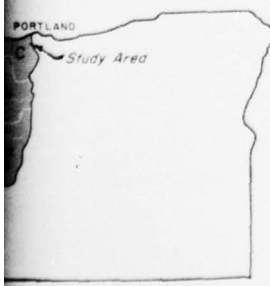
MAP 1
 WILLAMETTE BASIN STUDY
 OREGON
**EXISTING AND ASSURED
 PROJECTS**

1969



SUBAREAS

- A Upper
- B Middle
- C Lower



FUNCTIONAL PURPOSES

While multiple-purpose storage meets certain functional needs, it is only one of several methods employed to develop, use, and control the basin's water resources. Specialized improvements have also been provided to serve specific purposes. Developments oriented to each purpose are described following.

Fish and Wildlife

As development of the basin took place, habitats for fish and wildlife decreased and populations thereby fell. Fish and wildlife programs were instituted to regulate harvesting and to assure adequate numbers.

The basin's fish populations are sustained and enhanced through the operation of seven salmon and steelhead hatcheries and three trout hatcheries. Fish passage facilities have been constructed at several barriers. When the partially completed ladder system at Willamette Falls is finished, it is expected to greatly expand fall chinook salmon runs.



Fish hatchery at Leaburg on McKenzie River.

Wildlife improvements include game refuges and wildlife management areas. The five management areas in the basin total more than 19,000 acres. Recently established wildlife refuges for protection of Canada geese and other wildlife will, when complete, add another 10,700 acres.

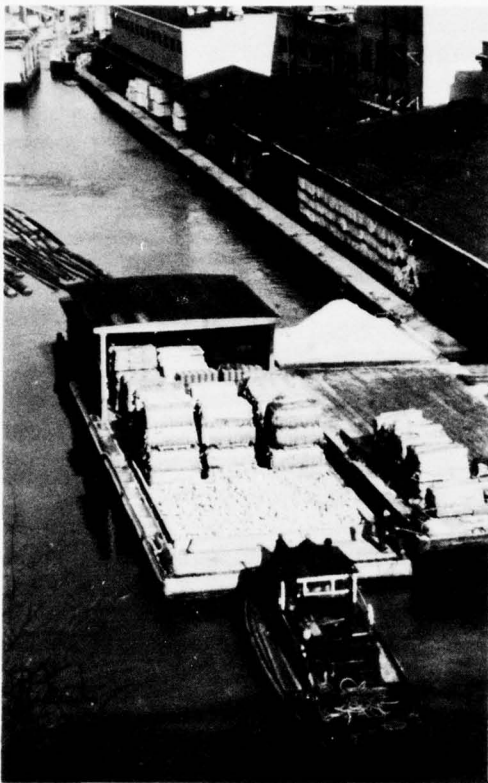
Flood Control, Channel Improvements, and Related Works

A major function of the multiple-purpose reservoirs is flood control. Existing and authorized flood control space totals about 2 million acre-feet and runoff is regulated from an area of about 3,300 square miles. The existing projects have greatly reduced the frequency and magnitude of flooding; however, significant flood problems remain.

In addition, a number of other improvements have been developed to reduce flooding, improve drainage, and generally lessen the damaging effects of flood runoff. These include major channel stabilization works along Willamette River and major tributaries, minor bank and channel improvements, tile drains, open drains, levees, and flood gates.

Navigation

River transportation has been an important part of the Willamette scene since the earliest settlement. Present facilities include a deep-draft navigation channel from the mouth of the Willamette through Portland; a four-chamber, shallow-draft lock at Willamette Falls; and a shallow-draft channel upstream to the Albany-Corvallis area. There are numerous commercial facilities such as piers, wharves, drydocks, log dumps, loading and unloading devices, and other features consistent with Portland's being a major West Coast port.



Locks at Willamette Falls.

Power

The basin's total installed electric power generating capacity is 938,000 kilowatts—718,000 kilowatts at 35 hydroelectric plants and the remainder at 23 thermal plants. More than half of the hydroelectric generating capacity is at Federal reservoir projects. The power requirements greatly exceed the generating capacity and the basin is heavily dependent on outside sources of power.

Recreation

The extensive natural resources of Willamette Basin have provided the backdrop for considerable recreational development. There are more than 4 million acres classed as suitable for outdoor recreation. This includes 106,000 acres of water surface on

streams, lakes, and reservoirs. Willamette River has great potential as a recreation resource but at present is lightly used.

Recreational facilities include 35 state parks, about 850 camping and picnicking sites, more than 90 public boat launching ramps, and numerous commercial developments including ski areas and resorts. A most important aspect of the Willamette recreational resource is the extent of forest and water areas which are not developed but are accessible to public use. Vast areas of the basin are used by hunters, fishermen, backpackers, cross-country skiers, and motorists; these areas are not developed, in the strict sense, but they are clearly a major part of the basin's recreation resource.

There are 17 areas totaling about 370,000 acres which, because of their particular recreational, scenic, and scientific values, have been classified as special areas. Three of those areas, totaling about 2,200 acres, have been classified as Research Natural Areas to protect specific vegetative types, preserving them as ecological benchmarks for scientific study. The accompanying table shows the acreage within Willamette Basin in each of the 17 areas.

	<u>Area</u> (acres)
<u>Wildernesses:</u>	
Diamond Peak Wilderness	16,200
Mt. Hood Wilderness	2,320
Mt. Jefferson Wilderness	66,174
Mt. Washington Wilderness	38,030
Three Sisters Wilderness	136,833
Subtotal	259,557
<u>Classified Recreation Areas:</u>	
Little Crater Geological	5
Lowder Mountain Geological	140
Mt. Hood Recreation	30,720
Quaking Aspen Swamp Botanical	240
Rebel Rock Geological	700
Yankee Mountain Scenic	490
Waldo Lake Recreation	32,600
Columbia Gorge Recreation	28,787
Subtotal	93,682

Classified Unique and Natural Areas:

Gold Lake Bog Natural	463
H. J. Andrews Experimental Forest	15,000
Olallie Ridge Natural	720
Wildcat Mountain Natural	1,000
Subtotal	17,183

Total Classified Acreage 370,422

Water Pollution Control

As of 1965, there were 92 municipal and 47 industrial waste treatment facilities operating in the basin. These developments include municipal plants, a variety of industrial plants, and the Portland plant, which serves a 370,000 population. In total, the waste treatment facilities reduced the 1965 waste loads from a population equivalent of more than 6 million to a population equivalent of 1.45 million. Conservation measures also constitute part of the existing water pollution control development.

Irrigation

Irrigation development, which started in 1890, reached a level of approximately 244,000 acres by 1965. Sixty percent of the irrigation is from surface water and nearly all water is applied by sprinklers. To date, the great majority of irrigation im-

provements have been by individual farmers. Less than 25,000 acres are in cooperative projects; however, there is a distinct trend toward cooperative development.

Municipal and Industrial Water Supply

In 1965, the basin had a total of 78 municipal water supply developments. Ground water was the source for about half of the systems but supplied only 10 percent of the people served. Three major service-area systems, Eugene, Salem, and Portland, served nearly 80 percent of the 1.1 million people using municipally supplied water.

The availability of relatively high quality water in large amounts has not been the sole factor in location of industries in the basin; however, it has unquestionably contributed to industrial growth. The major "wet process" industries in the basin are food processing and pulp and paper manufacturing. The pulp and paper industry is nearly 100 percent self-supplied. The food processing industry is supplied primarily by municipal systems, and its demand is an integral part of the municipal requirement. Other industries also rely upon water, but their demands are small.

Ground water is the main source of supply for rural-domestic use. The supply generally is adequate, but there are some locational deficiencies.



Irrigation water is applied primarily by sprinklers.

WATER MANAGEMENT PROGRAMS

Water Rights

An indication of the extent of water use and development can be gained from review of State-issued water rights. The laws of Oregon identify 10 beneficial uses of

water: domestic, municipal, irrigation, power generation, industrial, mining, recreation, wildlife, fish life, and pollution abatement.

Water rights summary as of July 1965

<u>Use</u>	<u>Surface Water</u> (cubic feet per second)	<u>Ground Water</u>	<u>Total</u>
Domestic	61	5	66
Irrigation	4,554	2,053	6,607
Municipal	956	226	1,182
Industrial	505	192	697
Power	22,040	--	22,040
Mining	7	--	7
Recreation	74	1	75
Wildlife	9	2	11
Fish Life	784	5	789
Total	28,990	2,484	31,474

Water Use Programs

Water-use programs have been formulated and adopted by the Oregon State Water Resources Board for Upper, Middle, and Lower Willamette Basins. Those programs permit only certain uses in specific areas. The Water Resources Board also has set minimum streamflows to support aquatic life at 96 points in Willamette Basin. No withdrawals of water can be made below the flows established, except for prior rights, domestic or livestock uses, or water to be legally stored or legally released from storage. Maintenance of minimum flows in some locations is dependent upon releases from storage as well as on natural flows.



North Santiam River.

Development and use of our rivers and streams must reflect the future needs of the public as a whole.



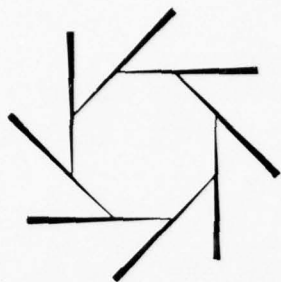
Ugliness is not an inevitable cost of modernity.
William O. Douglas



Recreation is no longer simply having your fun. Rather, it involves the kind of America we have, and want to have, and the kind of people we are and are likely to become.

Laurance S. Rockefeller





NEEDS AND ASSOCIATED PROBLEMS

The basic problem in Willamette Basin is the ever-increasing demand on space and resources of a growing population. Within 30 years, for every person now living, working, and recreating here, there will be two people. By 2020, just 50 years hence, there will be three people.

The dramatic increase in population will bring about a multitude of problems, many of which involve water and related land resources. For example, to maintain the same production per person, there must be a three-fold increase in production of food and fiber. This is complicated by an expected 20 percent decrease in agricultural land due almost entirely to urban expansion. To accomplish this production need, irrigated acreage must be increased four-fold; crop varieties must be improved; fertilizer, insecticide, and herbicide use will have to be increased; and zoning of choice agricultural lands on flood plains must become a reality. Special management will be needed to minimize stream pollution and preserve fish and wildlife.

With three people for every one now living in the basin, the problems of maintaining adequate water quality in the basin's rivers and streams will multiply. Even with progressively improved treatment of wastes, the disposal of residual wastes will still be a problem of considerable magnitude.

Meeting the recreational needs of the present population taxes the capacity of many of the major parks, forest camps, and waterways. A three-fold increase in population combined with greater mobility, more

leisure time, and more income will result in more than a four-fold increase in recreational demands.

To many basin residents, the greatest change, and thus the overriding problem, will come in the basin's environment. Each new person and each work of man designed to satisfy some demands of a growing population will alter the total environment. For example, new homes, industries, roads, and transmission lines will take away some agricultural and forest lands; new dams to control floods and conserve water will inundate land and change the stream regimen. It is inevitable that, with the increasing population, there will be changes in the face of the land, changes in the availability and use of resources, and changes in the priorities assigned to both use and preservation of resources.

The Willamette Basin Comprehensive Study was initiated because of those and other growing needs for use and management of the basin's water and related land resources. Although the basin had been studied many times in the past and much had been accomplished, it was apparent that there remained serious problems and significant unsatisfied needs.

A first step in the study process was to identify needs more clearly. The record of public hearings which were held at the beginning of the study provided a general description of problems and potential solutions as seen by the people of the basin. The determination of the nature and extent of specific needs was done by committees organized along the lines of the project

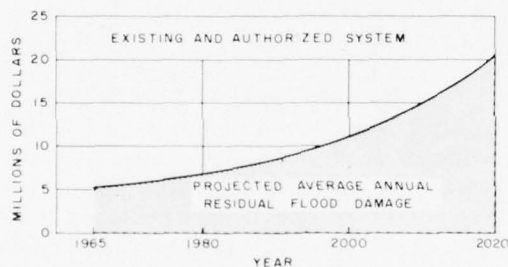
functions recognized by Congress. Additional consideration was given to environmental problems as they relate to water

resource development and also to legal and institutional problems and constraints.

FLOOD CONTROL

Although much progress has been made in the last 30 years in alleviating flood problems, continued development in the flood plain has expanded the potential for future flood damages.

Existing and authorized Federal storage projects are capable of controlling most floods at the project site and of reducing flood flows to less than bankfull levels for some distance downstream. However, there are many miles of stream system in which there is no storage control or where the amount of control is inadequate to control peak flows to nondamaging stage.



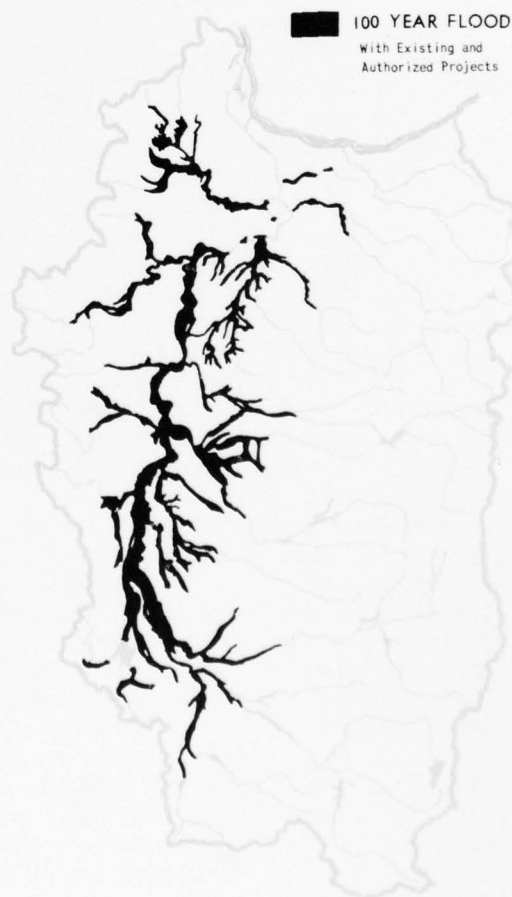
The basic need in the area of flood problems is to reduce potential damages, both present and future, and yet provide for appropriate use of areas in the flood plain consistent with the degree of hazard. Even with completion of the base system of projects and programs, there still will exist a potential for \$7.1 million in average annual damages in 1980. By 2020, that potential is projected to increase to \$20.3 million.

There are two major means of reducing flood damages: structural and nonstructural. Structural means include modification of existing storage facilities and construction of new storage, levees, and channel works. Nonstructural means include maintenance of vegetative cover to stabilize runoff and reduce downstream sedimentation and locally enacted measures

to regulate flood plain use—zoning, flood proofing of developments, tributary land treatment programs, and informational programs. Flood forecasting and warning services also reduce damages.

Flood control cannot be achieved in Willamette Basin by reservoir storage alone, because not enough storage sites are available for development. Many otherwise suitable sites cannot be used because of geologic conditions, insufficient drainage area controlled, or high land acquisition costs.

FLOOD PLAIN



Thus, a combination of structural and nonstructural measures will be required to achieve flood damage reduction in the basin.

Conflicts of both water and land uses complicate the problem of achieving flood damage reduction. Flood control operation of multiple-purpose reservoirs generally is compatible with other uses of storage because the flood season occurs during the winter rainy period when other demands are low. However, the need to provide empty storage space for flood control conflicts at times with project service to various water uses, primarily because some

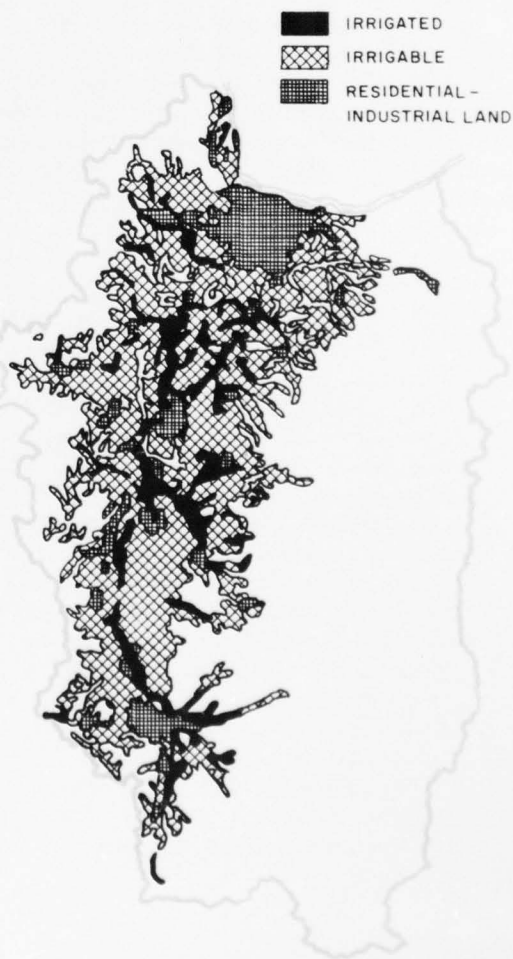
of the reservoirs cannot always be completely filled after the flood season. Although infrequent, such occurrences adversely affect recreation, fish and wildlife, irrigation, navigation, water quality, power generation, and water supply. Gravel removal incidental to channel enlargement reduces spawning areas, and construction and maintenance activities may cause temporary turbidity. Construction and maintenance of channel alterations, revetments, levees, and other works may prove to be partially incompatible with fish, wildlife, and recreation use of the river.

IRRIGATION

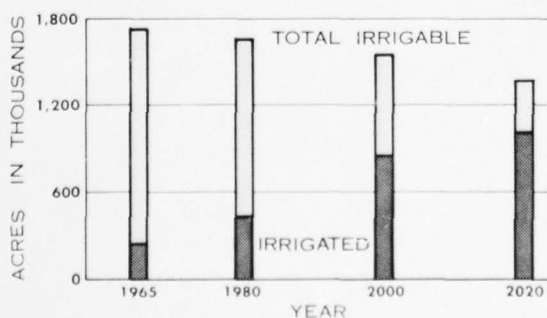
The basic need in terms of irrigation is for increased production of food and fiber. Irrigation projections are predicated on the premise that the basin will continue to supply its proportionate share of the Nation's food and fiber production. This is a reasonable assumption because: (1) the basin has over 1.7 million acres of good quality irrigable land, of which only 0.24 million acres are presently irrigated; (2) there is an abundant supply of high quality water; and (3) there is strong local interest in developing additional irrigation. It is expected that 430,000, 850,000, and 1,000,000 acres will be irrigated in 1980, 2000, and 2020, respectively.

Average annual diversion requirements for these lands are estimated to total 1,158,000, 2,192,000, and 2,460,000 acre-

POTENTIALLY IRRIGABLE LAND



IRRIGATION PROJECTIONS



feet in 1980, 2000, and 2020, respectively. Since the total diversion requirement for irrigation in 2020 is less than 10 percent of the basin's average annual runoff, problems of water supply are primarily those of areal and seasonal distribution rather than quantity.

Major alternative sources of water be-

yond the use of natural flows are : (1) storage in existing reservoirs, (2) construction of new reservoirs, and (3) ground water. It is anticipated that all of those sources will be utilized to meet the demand. They could be developed either individually or cooperatively, depending on specific conditions in a particular location.

POWER

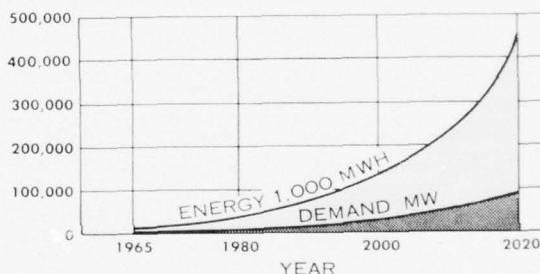
Willamette Basin imports about three-fourths of its power. Its installed generating capacity is about 5 percent of that for the region, but it consumes about 25 percent of the region's electric power.

The basin's annual energy requirement by 2020 is projected to increase to almost 35 times the 1965 energy use. Peak demands would amount to about 90 times the basin's present installed capacity.

Since there are no major undeveloped sites for generation of hydroelectric power by conventional means in the study area, it is apparent that future needs will have to

be met from thermal plants, pumped-storage hydroelectric plants, and from imports.

POWER REQUIREMENTS



NAVIGATION

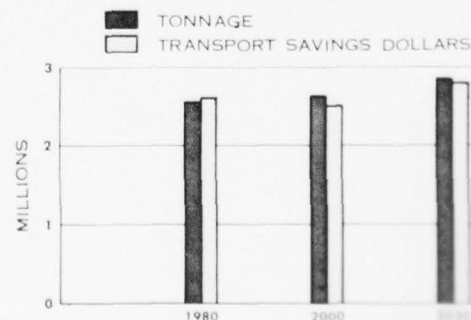
The basic need as related to navigation is for economic means of transporting goods. Movement by water is suited primarily to bulk cargoes. Commodities which would likely move by water are wood chips, rafted logs, petroleum products, sand and gravel, and agricultural supplies.

The present navigational improvements would allow expansion of navigational use in lower Willamette River up to the falls at Oregon City. Enlargement of the existing locks at the falls is a prerequisite to expansion of navigation upstream. Wider and deeper channels are also necessary if full navigational use of the river upstream from Oregon City is to be realized.

The following illustration shows (1) potential navigation use of Willamette River for commodities originating from or

destined to the reach between Willamette Falls and the Albany-Corvallis area, and (2) the potential annual savings under ideal conditions.

NAVIGATION POTENTIAL



AD-A036 745

PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
THE WILLAMETTE BASIN COMPREHENSIVE STUDY OF WATER AND RELATED L--ETC(U)
1969

UNCLASSIFIED

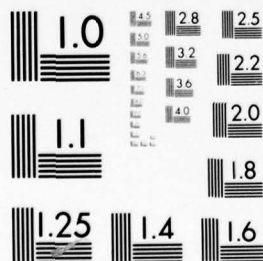
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

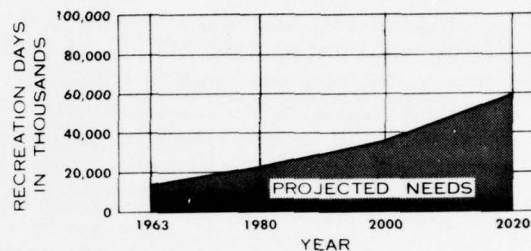
RECREATION

Recreation has become a basic human need just as are food, shelter, and a means to a livelihood. As the complexity and mechanization of life increases, so the need to occasionally escape increases. And just as each person's interests are different, so each person's recreational needs are also different. If an area is to meet its people's demands for recreation, it must have a multiplicity of opportunity ranging from facilities for the young and athletic to those for the mature and less mobile. These various needs have been lumped together and expressed in terms of recreation-days.

Recreational facilities create recreational opportunities as well as providing for recreational need. Present recreational facilities in the basin often are used to capacity and people are turned away. As additional facilities are provided, they too will be

used. The projected demand for outdoor recreation by 2020 is more than four times the demand in the 1960's. The most pressing need for facility development is in the Middle Subarea; the Lower Subarea is more limited in developable resources.

WATER RELATED RECREATION NEEDS



WATER POLLUTION CONTROL

The basic demand for water quality is directly dependent upon the uses to be made of the water. There is a strong public demand that water quality levels in nearly all basin streams be maintained or restored so as to provide adequate quality for water-contact sports and for maintenance and enhancement of the existing and potential fishery resources. The State of Oregon has adopted quality standards which, in general, call for dissolved oxygen concentrations of 5 to 7 milligrams per liter depending on location, summer water temperatures below 70 F., bacterial concentrations which do not exceed 1,000 coliform organisms per 100 milliliters, sediment concentrations not to exceed 5 Jackson turbidity units, and varying maximums for concentrations of dissolved chemical substances.

Presently, Willamette River is underutilized for fishery, recreation, and esthetic purposes. Lack of adequate water quality is one of the reasons. As the demand grows in the future, the Willamette and lower tri-

butary reaches will have to provide an increasing portion of the resource supply for those functions, and a significant improvement in water quality will be required. Industries and municipalities are continuing to improve their waste treatment facilities.

The existing Willamette Basin Project, with its many reservoirs, was authorized to provide specifically for flood control, power, navigation, and irrigation. In the several reports recommending authorization, water quality flow needs were recognized, and it was stated that the navigation flows of 6,000 cubic feet per second at Salem would provide for the water quality needs. Since that time, water quality management of the basin has been based upon the continued availability of those flows to meet navigation requirements. Projected 2020 requirements for the Portland Harbor area are for an August flow of 7,500 cubic feet per second, together with adequate at-source treatment of wastes.

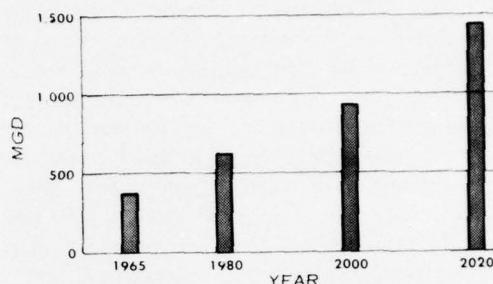
MUNICIPAL AND INDUSTRIAL WATER SUPPLY

Willamette Basin has ample sources of ground and surface water to supply the existing and projected domestic, municipal, and industrial needs. The total supply is adequate even in the face of demands that are expected to increase from 370 million gallons per day in 1965 to 1,440 million gallons per day in 2020.

Continued urbanization is expected to be the trend over the next 50 years, and existing municipal systems will have to be expanded to meet the needs of suburban areas. The major problem and the associated need will be for storage, treatment, and distribution of water supplies. As the total water use expands and more and more

of the land base is used, the availability of water for high-quality uses without purification will diminish.

PROJECTED WATER USE



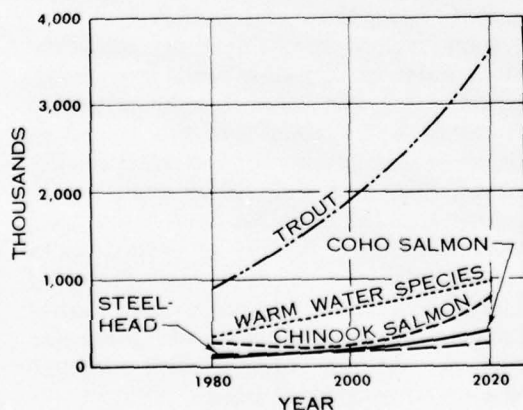
FISH AND WILDLIFE

The fish and wildlife resources of the basin are a significant part of the basin environment which makes the area a desirable place to live. The need for enhancement and preservation of those resources is not entirely a need for a certain number of fish or animals. It includes the need for maintaining a multiplicity of opportunities to fish, hunt, and observe fish and wildlife in their natural habitats. To many people,

simply knowing that the various forms of natural life exist and will continue to exist in their natural habitat is of utmost importance.

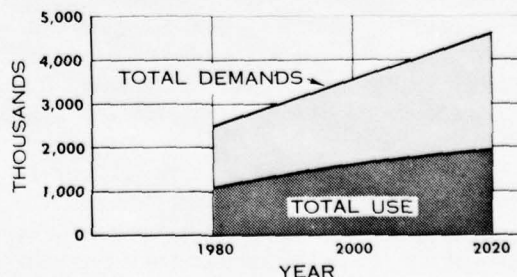
For purposes of planning, these resources should be maintained and enhanced to the maximum levels of production. The requirements include fish for harvest in the Columbia River and Pacific Ocean sport and commercial fisheries. Experience has shown that the resources will be used if they are available.

PROJECTED UNMET NEEDS - FISH



PROJECTED ANNUAL
WILDLIFE USE & DEMAND

In Hunter Days



LAND MEASURES AND WATERSHED PROTECTION

If the land is to be used without deterioration, it must be maintained by some natural or managed means. In addition, those lands that have suffered from abuse must be restored. Future demands

will have to be met from a nonexpanding land base. Land use projections show a decline in the agricultural and forest land base and an increase in urban development.

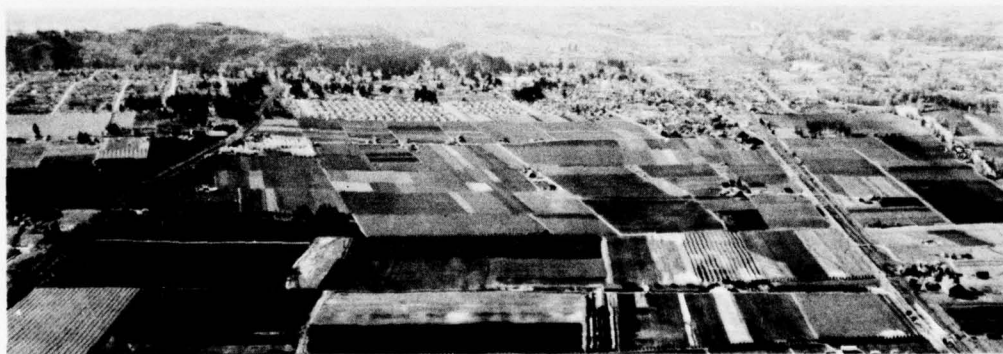
Land Use	Land Use			
	Present and Projected Acreage			
	1965	1980	2000	2020
	(1,000 Acres)			
Dryland crop	1,212	1,005	571	372
Irrigated	244	430	850	1,000
Native pasture	237	202	156	113
Woodland	5,101	5,054	4,983	4,885
Urban	332	434	568	773
Others	583	584	581	566
Total	7,709	7,709	7,709	7,709

Historically, a majority of urban and industrial development has taken place on prime agricultural lands. The remaining lands must provide the essential production requirements as well as the demands for beauty, open space, and outdoor recreation. Valuable farmlands should be protected from further encroachment by land use zoning. Considerable soil erosion and consequent sedimentation have resulted from urbanization of lands.

Erosion hazards will increase as the

remaining lands are more intensively farmed. Improvements will be made to reduce flooding and adapt wetter lands to a wider variety of crops. Even so, problems will be accentuated and costs of management for multiple land uses will increase.

Forest land needs, like agricultural land needs, are those of maintaining a renewable resource. Certain areas of both public and private forest lands are in need of reestablishment of timber stands and also erosion control.



Urban encroachment - shifting land use patterns - problems.

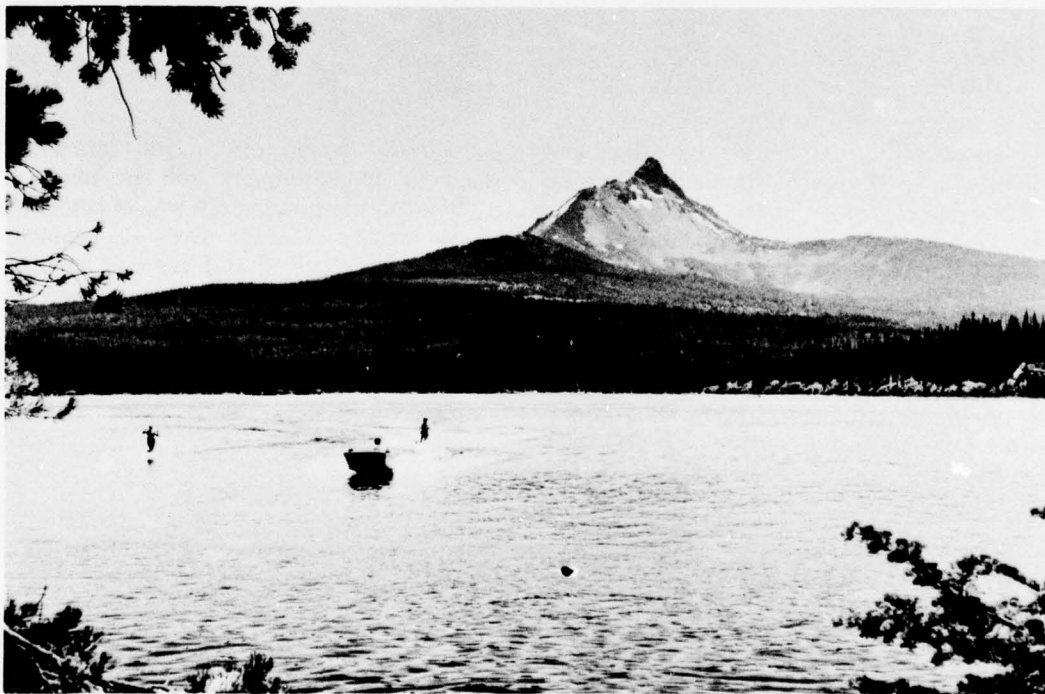
ENVIRONMENTAL CONSIDERATIONS

The overriding problem or need is to maintain the quality of life such that basic needs of an expanding population will be met and the basin will continue to be a desirable place to live. The natural environment plays a major role in the quality of basin living; the maintenance of that environment thus becomes a major concern or need to which all planning must be responsive.

The needs are to restore and preserve—to restore quality lost because of air and water pollution and destruction of scenic resources, and to preserve the remaining desirable and unique resources.

Each of the needs and problems expressed earlier in this section is interrelated to the problems and needs of the environ-

ment. Meeting needs for flood control or irrigation or water supply by constructing storage reservoirs brings about a drastic change in stream environment. Meeting needs for power means more transmission lines, with their accompanying environmental impacts. Even meeting needs for outdoor recreation opportunities often requires that portions of the natural scene will be altered. Meeting the needs for fish and wildlife means maintaining and enhancing desirable aspects of existing environment. The problem then is to make considered and knowledgeable choices between the alternatives for meeting needs or if there are no choices then to lessen as much as possible the adverse effects on the environment.



Water skiers on Big Lake with Mt. Washington in background.

No one has a right to use America's rivers and America's waterways that belong to all the people as a sewer. The banks of a river may belong to one man or to one industry or one state, but the waters which flow between those banks should belong to all the people.

Lyndon B. Johnson



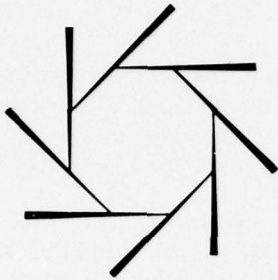


I was asked the other day what took most of my time as President, and I could answer without hesitation in one word: planning - planning - planning.

We just don't realize enough how pressing, and how urgent, and how critical it is for us to be planning today for America's future needs tomorrow -- needs 10, 20, 30 years hence, when this Nation will have three people for every two that we have today.

President Johnson, on July 22, 1965, during the signing of the Water Resources Planning Act





THE PLAN

This report presents a plan for continued development and preservation of the water and related land resources of Willamette Basin. The plan described here is the latest, but not the last, step in evolution of resource development proposals for the basin.

In 1932, House Document 263, 72nd Congress, 1st session, had these and other conclusions regarding Willamette River.

"Navigation is the most important use of the Willamette River between its mouth and Eugene. No

power or irrigation development which would cause the low-water flow in this stretch of the river to be diminished should be permitted.

"Further improvement of the tributaries of Willamette River by works for navigation alone or in conjunction with power or irrigation is unwarranted.

"There is no flood problem on the Willamette of sufficient magnitude to necessitate formulation of a general plan for flood control.



1964 flood at Corvallis on Willamette River.

"Irrigation of about 500,000 acres in the Willamette Valley by gravity diversions from the tributaries of Willamette River appears economically possible and could be accomplished without detriment to navigation if proper storage of the high-water flows of the tributaries were provided."

In 1938, House Document 544, 75th Congress, 3rd session, had these and other conclusions regarding Willamette River and tributaries.

"Further improvement of the nontidal section of the Willamette River is advisable in the interest of general commerce and navigation. There is urgent need for additional protection against floods in the Willamette Valley. Rainfall in the Willamette Valley is deficient during the growing season, and provisions for supplemental irrigation on a larger scale should be made in order to bring about full development of large agricultural resources valuable from a national standpoint. Stream pollution is fast becoming a problem calling for remedial action. Power development is not now needed but provisions should be made at this time to insure full realization of power resources in the future."

That report recommended that existing navigation and flood control projects be modified to provide for construction of a system of reservoirs and regulation of streamflow.

House Document 531, 81st Congress, 2nd Session, published in 1950, noted "the primary accomplishments of the plan of improvement will be control of floods and solution of major drainage problems. After the flood season, stored water will be released in a manner best suited to provide increased depths for navigation, for generation of hydroelectric power, and for the several conservation uses, namely: irrigation, potable water supply, and reduction of stream pollution in the interests of fish conservation, public recreation, and public health."

The present comprehensive study includes consideration of needs in nine functional areas: flood control, irrigation, power, navigation, M&I water supply, fish and wildlife, recreation, water quality control, and land measures and watershed protection. The plan presented here is responsive to needs which exist now or are anticipated to develop in the future. It should be clear from the past record that future conditions will require continual revision and updating of this plan.

The decision to undertake any project should rest on actual need ascertained by investigation and judgment of experts and on its relation to great river systems and to the general plan, never on mere clamor.

Theodore Roosevelt

FORMULATION PROCEDURE

Development of a plan to meet water and related land resource needs was the basic purpose of the Willamette Comprehensive Study. The procedure used followed a general four-part approach adopted at the beginning of the study:

1. Define and analyze needs for water and related land resources, including specific problems, goals, and objectives.
2. Appraise resources and measures available to satisfy needs and lessen problems.
3. Formulate a plan for water and related land resource control, conservation, and use.
4. Continue a program of public contacts and exchange of information, so that the plan will be responsive, understood, and supported.

These basic elements were accomplished through a series of more detailed steps:

1. Available basic data were evaluated to determine where additional information would be required.
2. Problems and needs were determined through public hearings, preparation of economic studies, and by special committees organized along functional lines.
3. Existing, authorized, and assured developments were analyzed and evaluated to determine the extent to which such development could meet future needs.
4. Available resources were inventoried to determine what potentials such as reservoir sites, undeveloped land, and storable water were available to meet future needs.

5. Ability of the private sector to meet future needs was considered.
6. Potentials for meeting needs were screened. Various structural and non-structural methods for controlling and managing water and related lands were considered in light of physical possibility, economic feasibility and public acceptance.
7. Results of the various steps were incorporated in a collective process termed plan formulation. Formulation studies consisted of matching needs with available potentials for resource preservation, control, and use. This matching was done, on an incrementally more detailed basis, over a considerable portion of the study period. The first matching was on a physical basis. Later, with more data available, the matching included both physical and economic analyses, supplemented by judgment and policy considerations.
8. Subbasin analyses were an essential part of the approach to formulation of the comprehensive basin plan. Consideration of needs and potentials at the subbasin level assisted in providing coverage of all aspects of plan formulation.

The plan which has been formulated provides an overall framework for use and development of Willamette Basin water and related land resources. Within that framework plan, there are three divisions: existing projects and ongoing programs; those projects and programs needed in the next 10-15 years; and projects and programs to meet needs for the additional 35 to 40 years of the total planning period.

Willamette Basin is, with the exception of Columbia and Sandy Subbasins, a hydrologically coherent area; each subbasin is a tributary drainage to Willamette River.

Each tributary subbasin, rather than being unique and separate, is a blending of the areas adjacent to it. Projects or programs initiated in one subbasin often meet needs in adjacent subbasins and in most cases affect Willamette River itself.

The plan for conservation and development of Willamette Basin water and related land resources consists of two basic parts: projects and programs. Projects include such plan elements as dams, reservoirs, channel alterations, navigation works, and

power and irrigation developments. The program category includes all water and related land activities not included as projects. Generally speaking, program elements include activities which extend over several years and cover broad areas. Examples are programs for reforestation, land stabilization, environmental management, fish and wildlife enhancement, and data collection. Proposed programs and projects would be used to serve all presently recognized water and related resource needs.

C O S T S

The overall comprehensive plan would involve an identified investment by 2020 in the order of \$6 billion in projects and permanent improvements under programs. As of that date, the average annual identified cost of operation and maintenance for the overall plan would be more than \$130 million. The following tabulation summarizes identified costs.

Cost allocations for individual projects

will be made in subsequent studies for individual agency reports, based on data herein plus additional detail yet to be developed. Thus, neither the total Federal and non-Federal shares of cost nor the total costs allocable to individual functions are known. It is estimated, however, that approximately 30 percent of cost of the early-action plan would be borne by non-Federal interests.

<u>Plan Elements and Categories</u>	<u>Estimated Costs, \$1,000,000</u>	
	<u>Investment</u>	<u>Annual O&M</u>
<u>Programs:</u>		
Functional	1,070	69.32
Other	89	0.63
Subtotals	1,159	69.95
<u>Projects:</u>		
Existing	441	3.11
Authorized and assured	191	0.91
Early-action	695	6.37
Long-range	3,260	50.00
Subtotals	4,587	60.39
Totals	5,746	130.34

PLAN ELEMENTS

The comprehensive plan for development and preservation of the Willamette Basin's water and related land resources consists of a number of water control and storage projects and various water-related programs. The plan presented here uses the existing system of storage and other projects as a base and adds to that base additional projects and complementary programs. The plan is designed to meet basin needs over a future 50-year planning period. Since there will be a great number of changes in the next 50 years, both in what type of development is needed and in how needs can be met, the plan is best viewed as a flexible framework into which various alternative projects and programs can be fitted.

Storage

The reservoir storage aspect of the plan would add 87 new storage projects plus modification of one existing reservoir and enlargement of one authorized reservoir, bringing the total storage capacity to 5.4 million acre-feet. Fifty-two of those proj-

ects should be started within the next 10-15 years and have thus been designated as early-action elements of the plan. The projects range in size from 1,000 acre-feet to more than 270,000 acre-feet. Most of the projects would be multiple-purpose.

Early-action and long-range storage projects are shown on the accompanying maps. Additional information on specific projects is included in Appendix M, Plan Formulation.

The 52 early-action storage developments included in the plan fall into two general categories: those 17 reservoirs which would be additions to or modifications of the basic operational system, and those 35 reservoirs which would be operated on a watershed basis.

The 15 new reservoirs and the Dorena modification and Holley enlargement described below are recommended additions to the base system. In total, they would add 1,349,000 acre-feet. Total storage to be available under the plan for operation as a system then would be 4.2 million acre-feet.

Early-Action Reservoirs			
Reservoir <u>Name</u>	Site <u>No.</u>	<u>Stream</u>	Storage <u>(ac.-ft.)</u>
Jordan	203	Thomas Cr.	93,000
Holley (enlargement of auth.)	—	Calapooia R.	48,000
Lyons	241	L.N. Santiam R.	110,000
Gorge	281	Mill Cr.	53,000
Noon	574	Marys R.	115,000
Pedee	302	Luckiamute R.	130,000
Moore's Valley	292	Haskins Cr.	30,000
Pike	306	N. Yamhill R.	75,000
Agency	253	S. Yamhill R.	78,000
Buck Hollow	261	Willamina Cr.	84,000
Gopher Valley	269	Deer Cr.	33,000
Dickey Bridge	348	Molalla R.	273,000
Grange	352	Silver Cr.	80,000
Selah	386	Pudding R.	22,000
Gaston	422	Tualatin R.	68,000
E. F. Dairy Cr.	417	E. F. Dairy Cr.	47,000
Dorena modification	—	Row R.	10,000
Total			1,349,000

The reservoir sites proposed in the 26 early-action watershed projects include identified alternatives not included in the previous plan total. These reservoirs, which are listed below, would provide an addi-

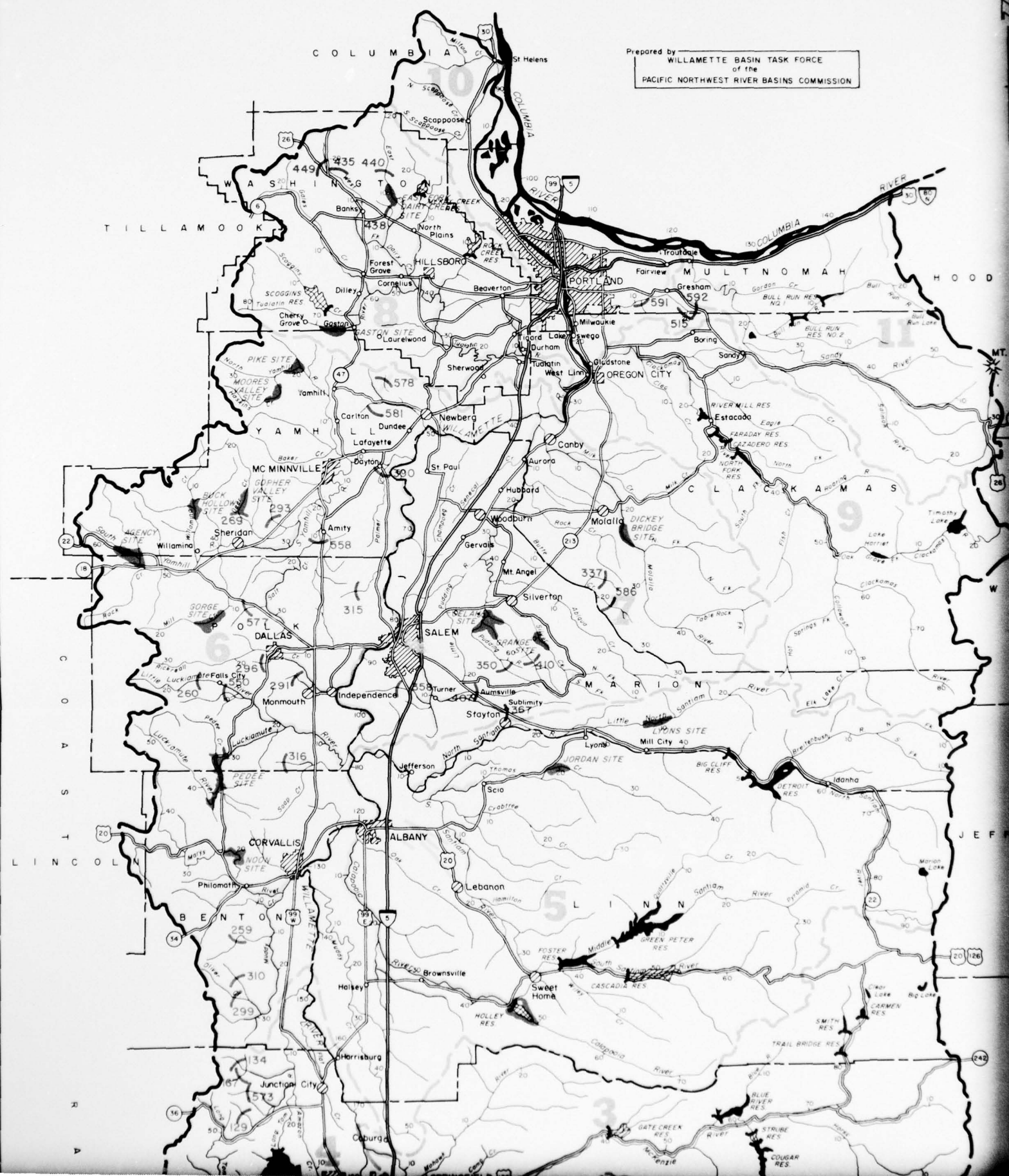
tional 271,100 acre-feet of storage, of which approximately 31,000 acre-feet would be available for meeting needs beyond individual watershed boundaries.

Early-action reservoirs associated with small watershed projects

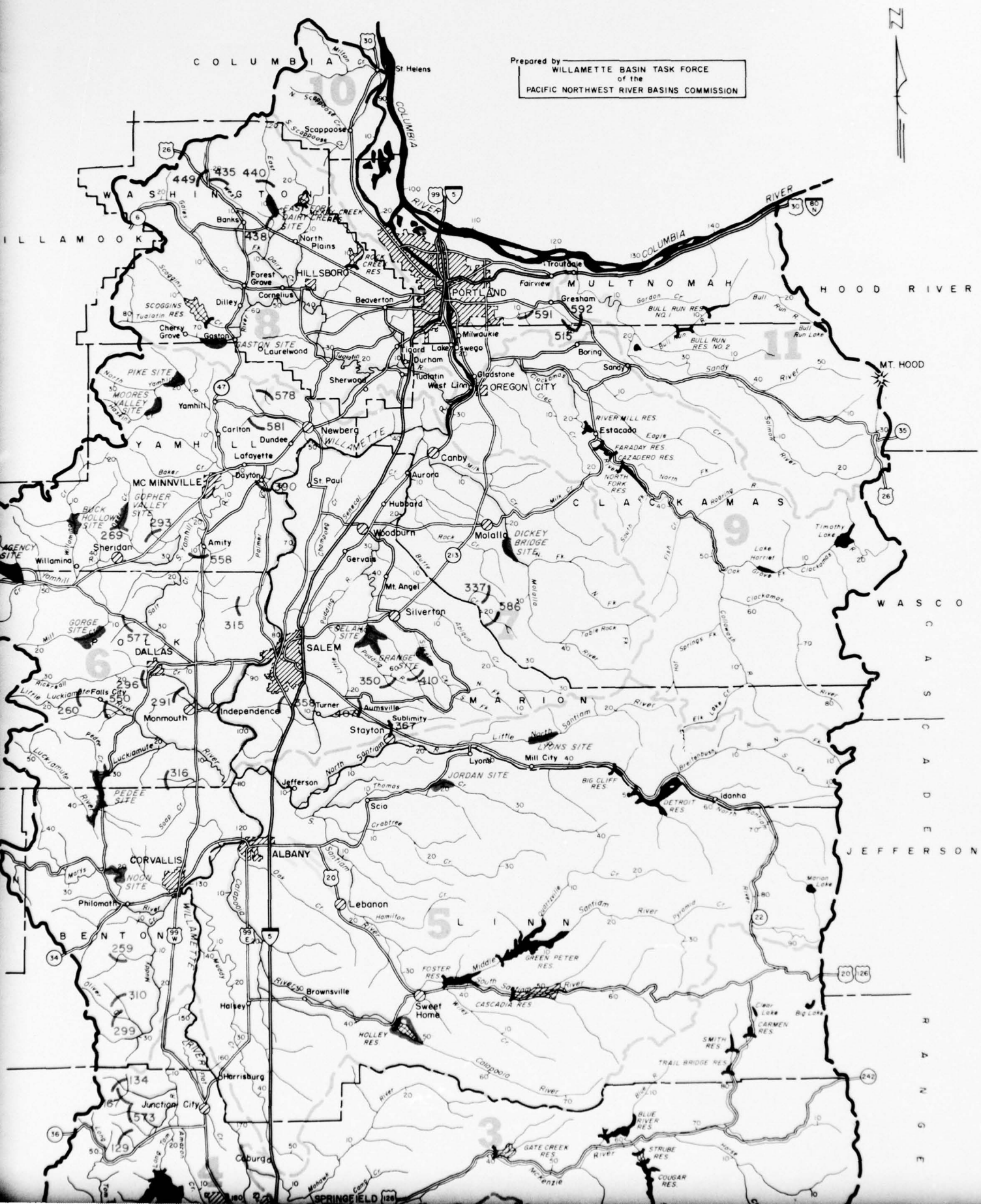
<u>Watershed Project</u>	<u>Site No.</u>	<u>Stream</u>	<u>Storage (ac.-ft.)</u>
Camas	17	N. F. Camas Swale Cr.	6,400
	26	Camas Swale Cr.	16,000
Cloverdale	25	Trib. Coast Fork	9,000
Coyote-Spencer	130	Coyote Cr.	10,000
	137	Fox Hollow	10,500
Bear	129	Bear Cr.	2,500
	573	Owens Cr.	8,200
Ferguson	134	Ferguson Cr.	6,000
	167	Trib. Ferguson Cr.	5,700
W. Muddy	259	Beaver Cr.	13,000
	299	Oliver Cr.	9,600
	310	Reese Cr.	9,600
L. Luckiamute	260	L. Luckiamute R.	6,000
	550	Teal Cr.	25,000
Soap	316	Staats Cr.	3,600
Ash	291	M. F. Ash Cr.	3,000
	296	N. F. Ash Cr.	3,100
Chehalem	578	Trib. Chehalem Cr.	2,400
	581	Trib. Chehalem Cr.	2,300
Palmer	300	Palmer Cr.	11,600
Salt	577	W. F. Salt Cr.	9,500
	558	Salt Cr.	8,400
Spring Valley	315	Spring Valley Cr.	4,800
Deer Creek 1/	293	Muddy Cr.	(18,400)
	269	Deer Cr.	(18,000)
Butte	337	Beaver Cr.	5,700
	586	Coal Cr.	15,600
Drift-Pudding	410	Drift Cr.	9,000
	350	S. F. Pudding R.	5,200
Mill	358	Battle Cr.	2,700
	367	Mill Cr.	5,900
	407	Beaver Cr.	21,200
W. F. Dairy	435	Witcher Cr.	6,100
	449	Trib. W. F. Dairy Cr.	8,100
E. F. Dairy 2/	438	Bledsoe Cr.	(8,000)
	440	E. F. Dairy Cr.	(10,000)
Johnson	515	Trib. Johnson Cr.	3,300
	591	Trib. Johnson Cr.	1,100
	592	Johnson Cr.	1,000
Total			271,100

1/ Alternative to Gopher Valley, site No. 269

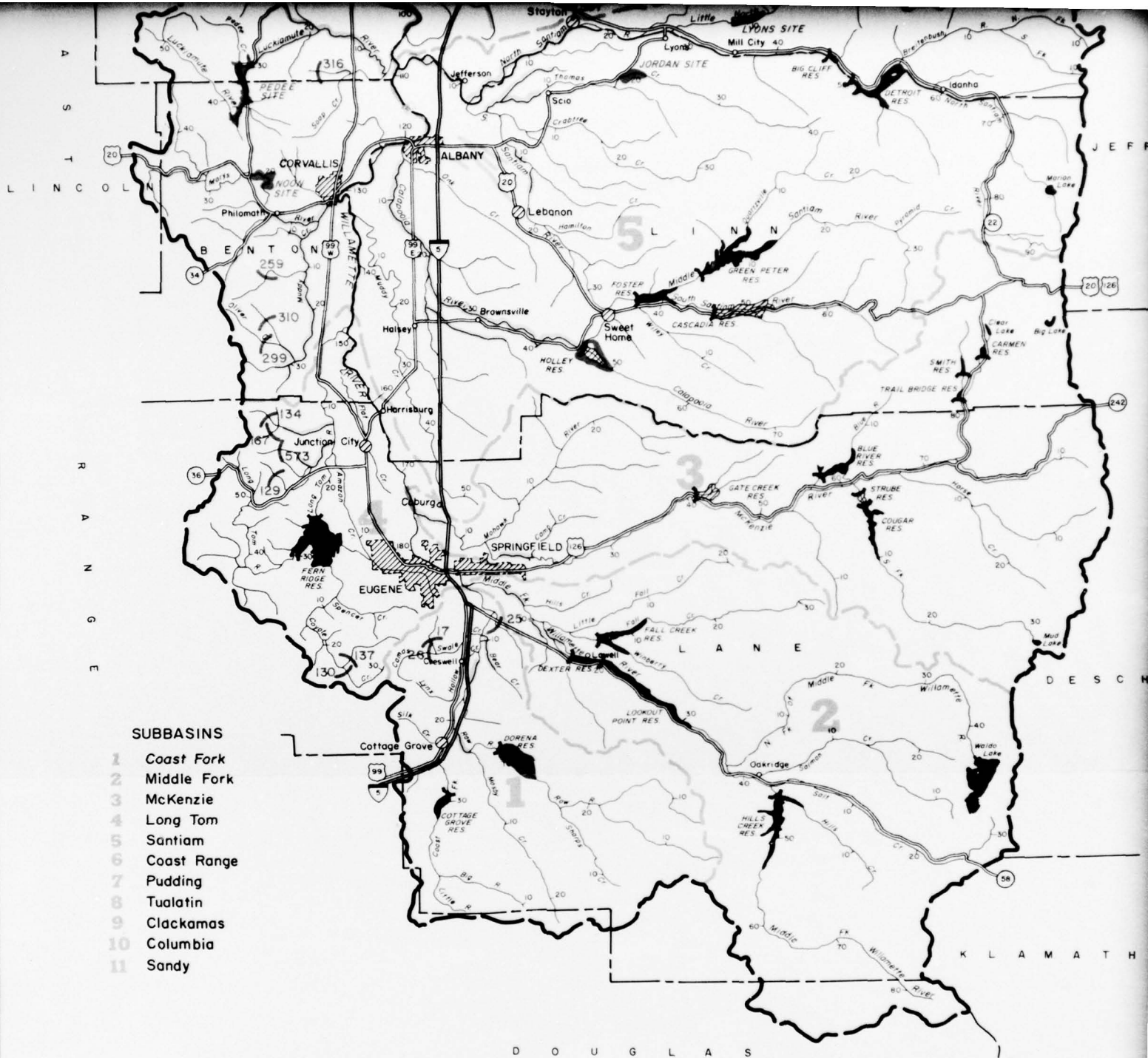
2/ Alternative to E. F. Dairy Cr., site No. 417



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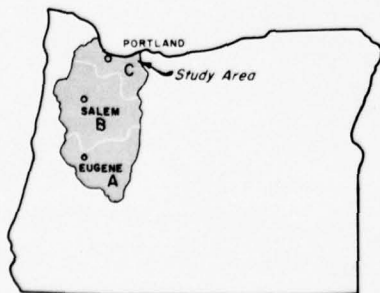


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SUBBASINS

- 1 Coast Fork
- 2 Middle Fork
- 3 McKenzie
- 4 Long Tom
- 5 Santiam
- 6 Coast Range
- 7 Pudding
- 8 Tualatin
- 9 Clackamas
- 10 Columbia
- 11 Sandy



SUBAREAS

- A Upper
- B Middle
- C Lower

LEGEND

RESERVOIRS

- Existing
- Authorized and Assured

EARLY ACTION PROJECTS

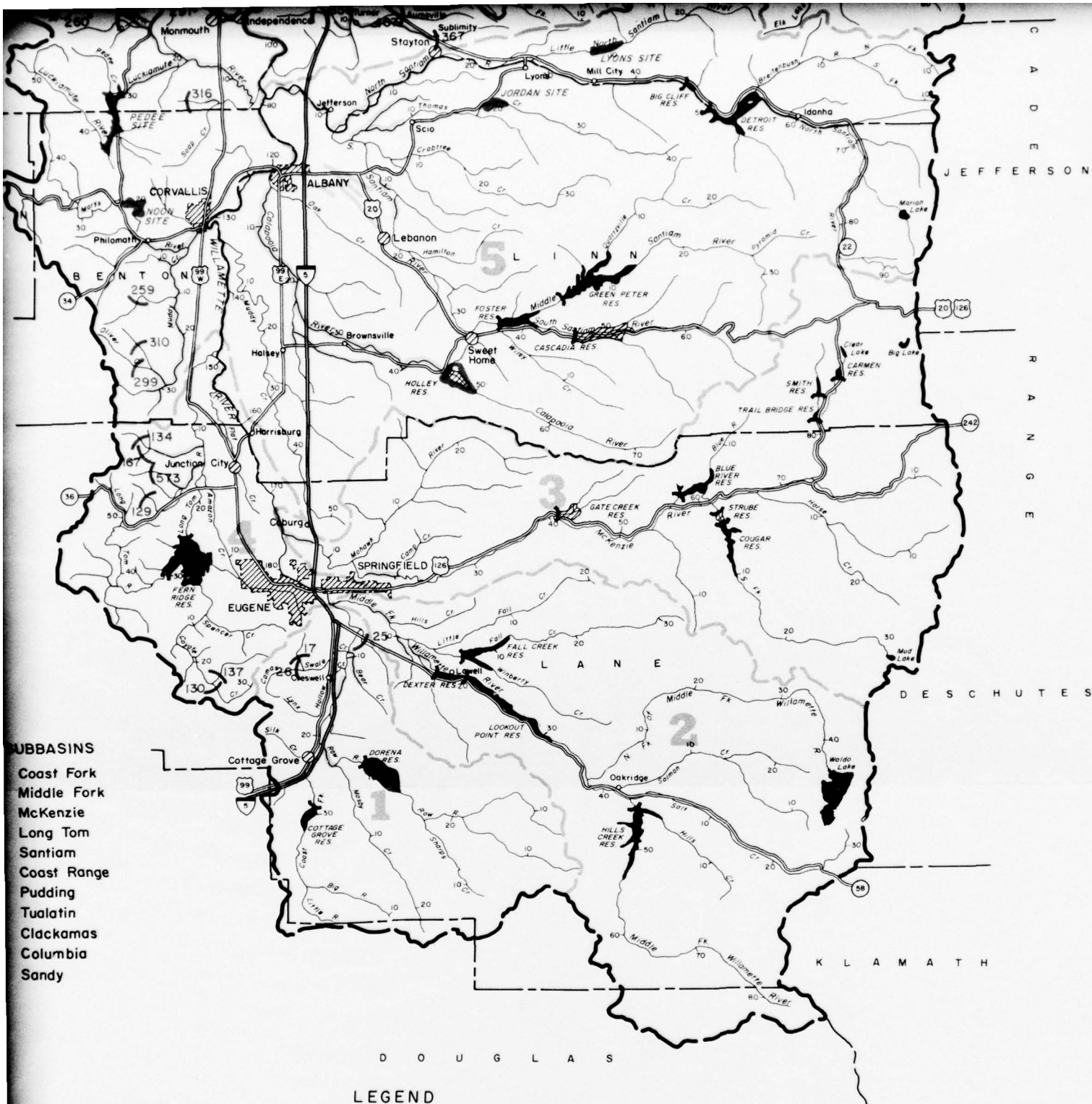
- Major Reservoirs
- Watershed Project Reservoirs
- Major Channels
- Minor Channels

Note: Channel symbols generalized

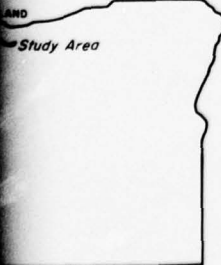
MAP 2 WILLAMETTE BASIN ST OREGON

EARLY-ACTION PRO

1969
SCALE IN MILES



SUBBASINS
 Coast Fork
 Middle Fork
 McKenzie
 Long Tom
 Santiam
 Coast Range
 Pudding
 Tualatin
 Clackamas
 Columbia
 Sandy



BAREAS
 Upper
 Middle
 Lower

- LEGEND**
- RESERVOIRS**
- Existing
 - Authorized and Assured
- EARLY ACTION PROJECTS**
- Major Reservoirs
 - Watershed Project Reservoirs
 - Major Channels
 - Minor Channels

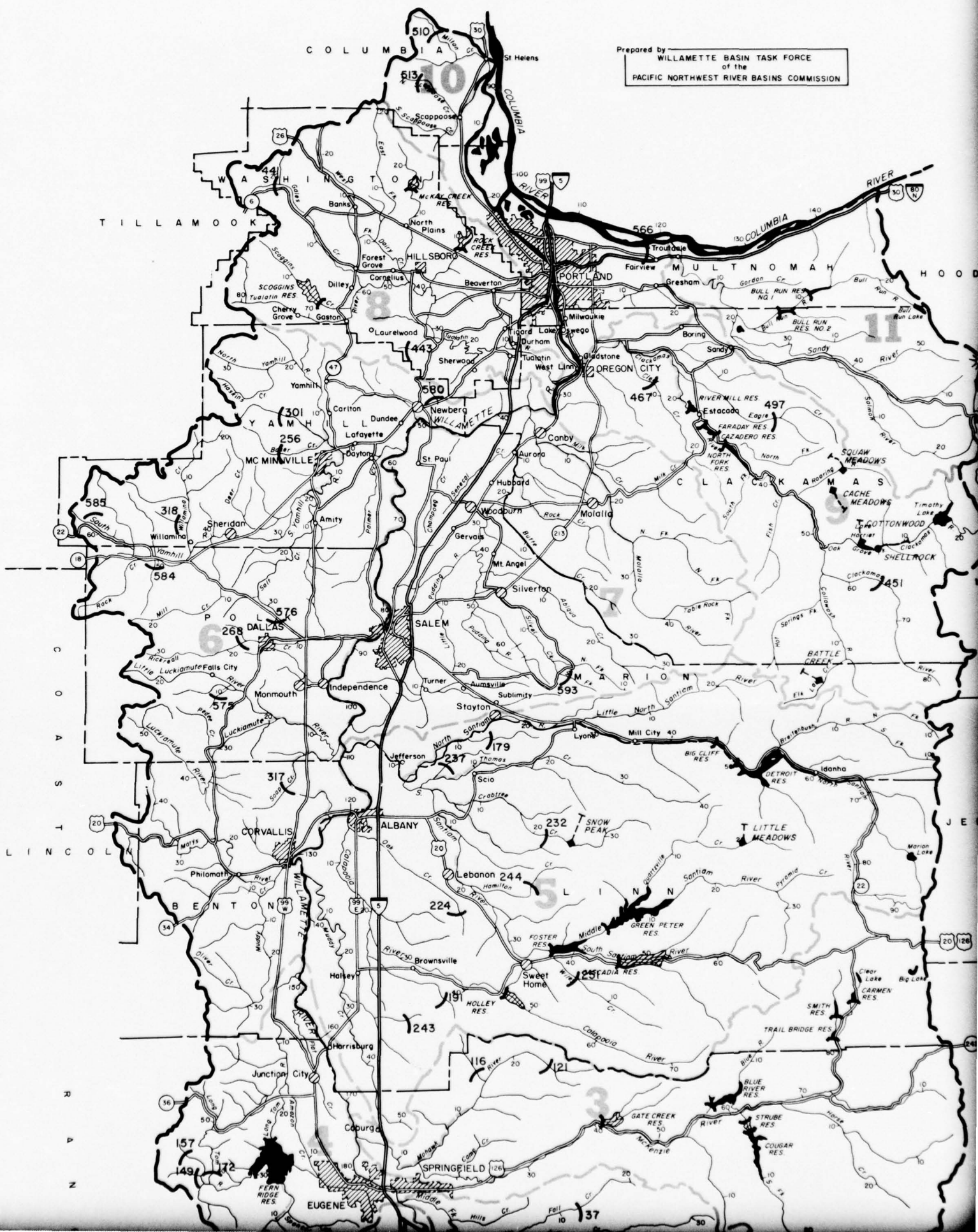
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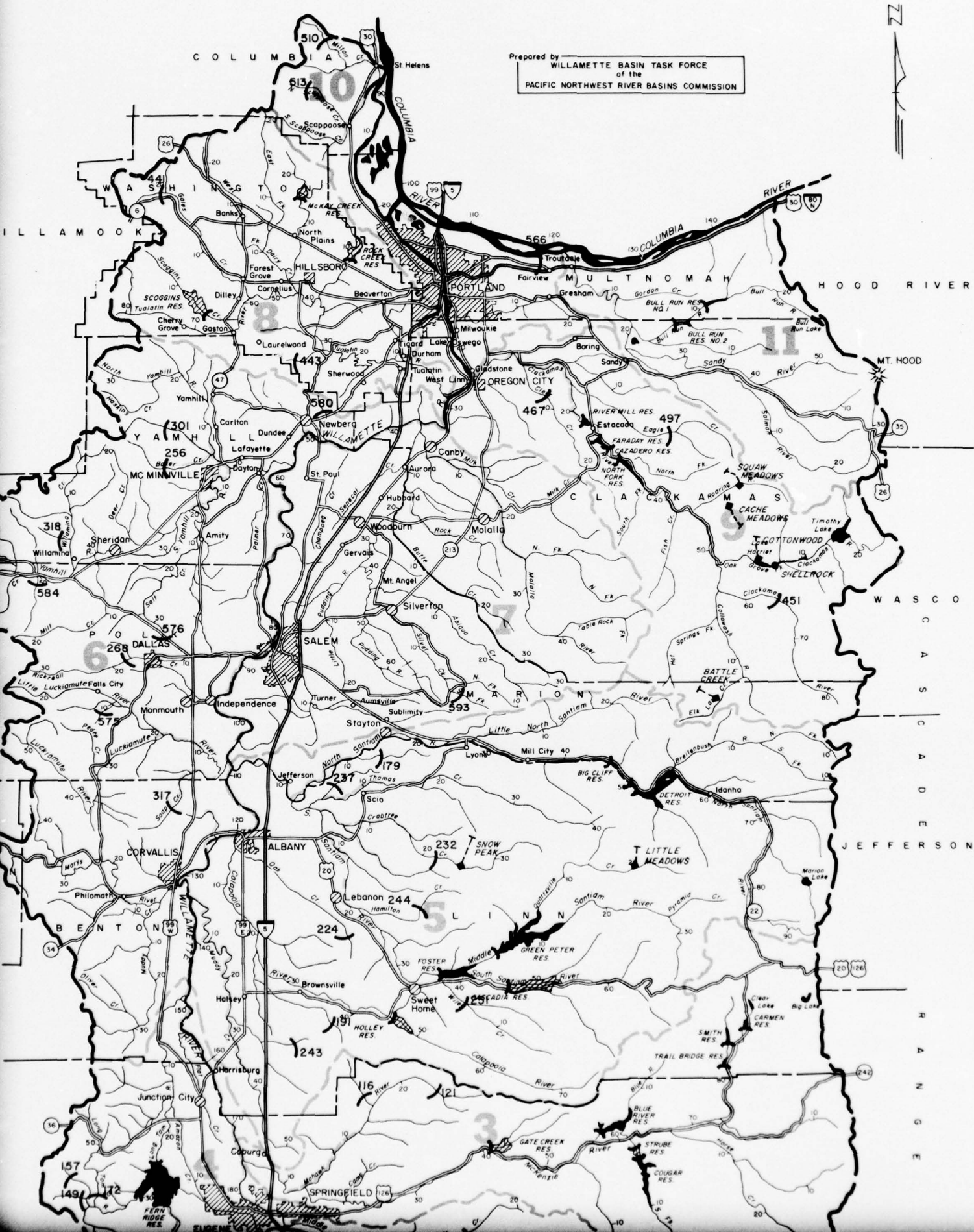
MAP 2
WILLAMETTE BASIN STUDY
OREGON
EARLY-ACTION PROJECTS



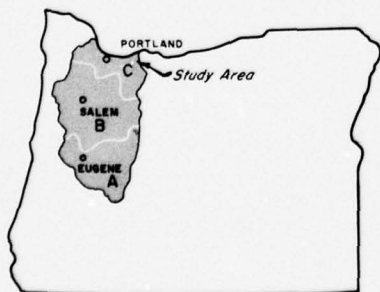
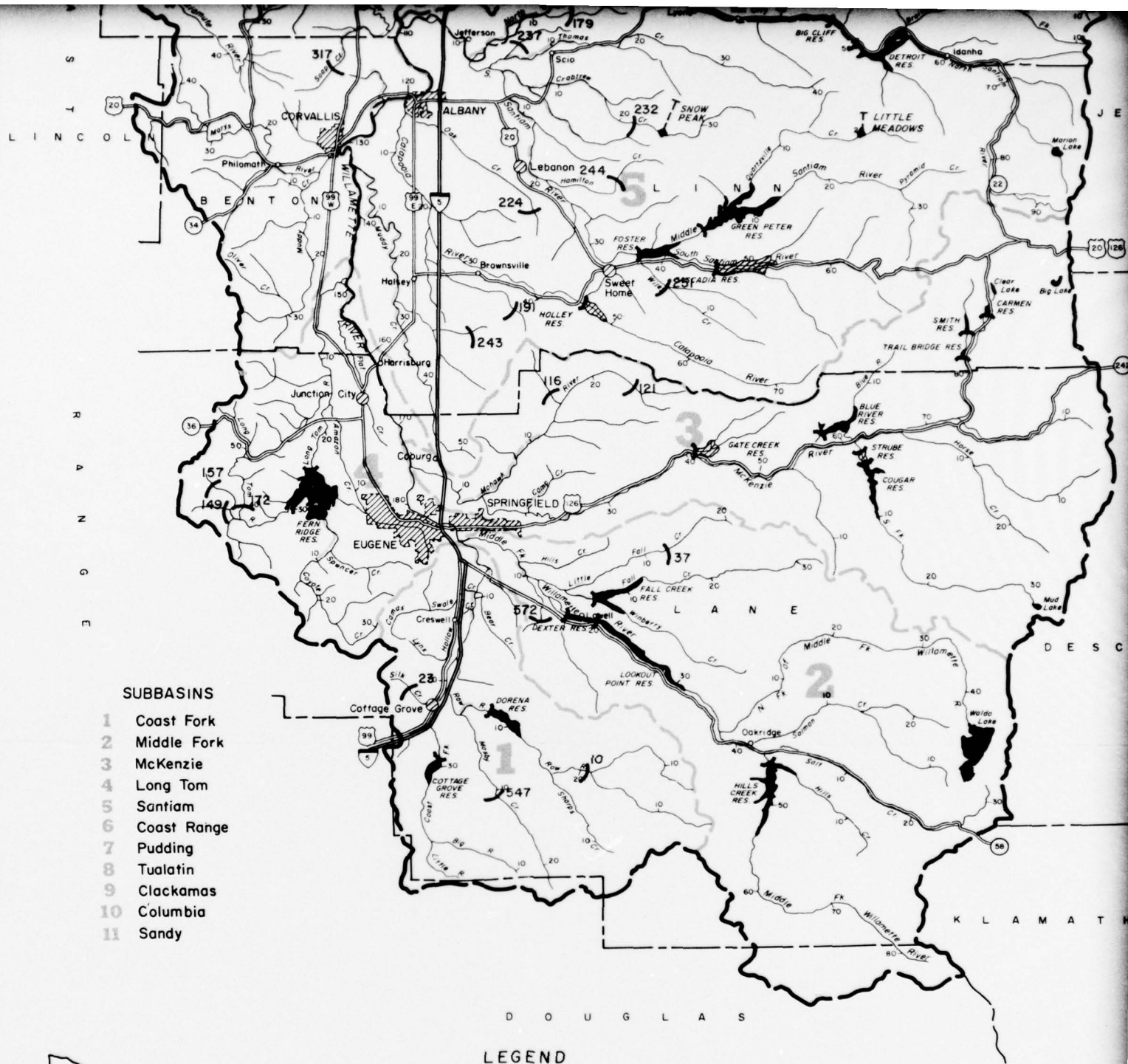
C O L U M B I A

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SUBAREAS

A Upper
B Middle
C Lower

LEGEND

RESERVOIRS

- Existing
- Authorized and Assured

LONG RANGE PROJECTS

- 510 Reservoirs
- Major Channels
- Minor Channels

SINGLE PURPOSE POWER PROJECTS

- Conventional
- Pump Storage

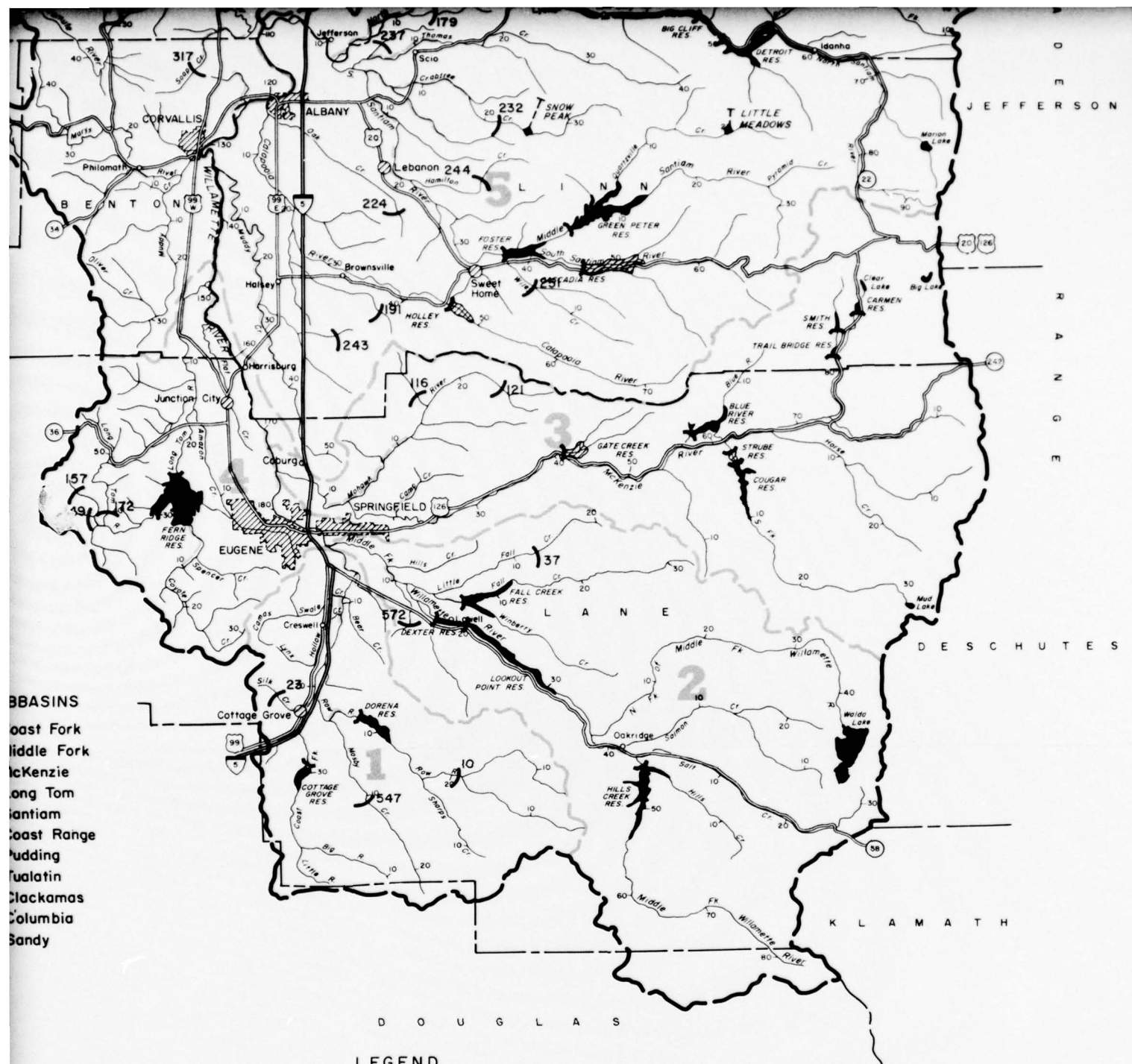
Note: Channel symbols generalized

MAP 3
WILLAMETTE BASIN
OREGON

LONG-RANGE PRO

1969

6 0 6
SCALE IN MILES



In addition to the 52 early-action storage proposals, the plan includes 37 reservoirs which would be needed to meet long-

range needs. The table below lists the site names, and shows locations and potential capacity.

Long-range reservoirs

<u>Reservoir Site</u>	<u>Stream</u>	<u>Storage (ac.-ft)</u>
Abrams - 547	Mosby Cr.	50,000
Disston - 10	Row R.	90,000
Silk Cr. - 23	Silk Cr.	7,900
Rattlesnake Cr. - 572	Rattlesnake Cr.	2,400
L. Fall Cr. - 37	L. Fall Cr.	20,400
Upper Mohawk # 2 - 121	Mohawk R.	24,500
Shotgun Cr. - 116	Shotgun Cr.	12,700
Upper Noti - 172	Long Tom R.	35,000
Poodle Cr. - 157	Poodle Cr.	14,300
Log Pond - 149	Elk Cr.	20,000
Sucker Slough - 237	Sucker Slough	7,200
Courtney Cr. - 191	Courtney Cr.	6,400
L. Muddy Cr. - 243	L. Muddy Cr.	3,400
Bear Br. - 179	Bear Br.	16,800
Oak Cr. - 224	Oak Cr.	7,200
Hamilton Cr. - 244	Hamilton Cr.	12,000
Wiley Cr. - 251	Wiley Cr.	65,000
Sawmill - 232	Crabtree Cr.	70,000
Sulphur Spring - 317	Soap Cr.	13,000
Salt Cr. - 576	Salt Cr.	3,600
Spring Brook - 580	Spring Br.	2,600
Dallas - 268	Rickreall Cr.	30,000
Rowell Cr. - 584	Rowell Cr.	26,700
Grant Cr. - 575	Grant Cr.	5,500
Panther Cr. - 301	Panther Cr.	19,500
Baker Cr. - 256	Baker Cr.	14,600
Tindle Cr. - 318	Tindle Cr.	11,700
Ead Cr. - 585	Ead Cr.	11,700
S. F. Silver Cr. - 593	S. Fk. Silver Cr.	24,600
Gales Cr. - 441	Gales Cr.	14,500
McFee Cr. - 443	McFee Cr.	12,500
Big Bottom - 451	Clackamas R.	120,000
Clear Cr. - 467	Clear Cr.	60,000
Eagle Cr. - 497	Eagle Cr.	21,000
N. Scappoose Cr. - 513	N. Scappoose Cr.	18,200
Milton Cr. - 510	Milton Cr.	10,000
Fairview L. - 566	Fairview Cr.	1,700
	Total	886,600

Structural Nonstorage

These elements are principally in the functional areas of flood control, irrigation, navigation, power generation, and recreation. Pumped-storage power installations are included, because such projects usually are closed systems which do not entail the conventional storage-and-release procedures so far as water in the stream system is concerned.

Overall, these elements of the plan would cost in the order of \$3.5 billion, or about 60 percent of total comprehensive basin plan cost. The cost of pumped-storage power generating installations accounts for more than two-thirds of those costs.

Flood control elements include: (1) existing, authorized, and assured channel and bank stabilization works; (2) early-action channel works; (3) watershed protection measures; and (4) additional long-range channel stabilization works.

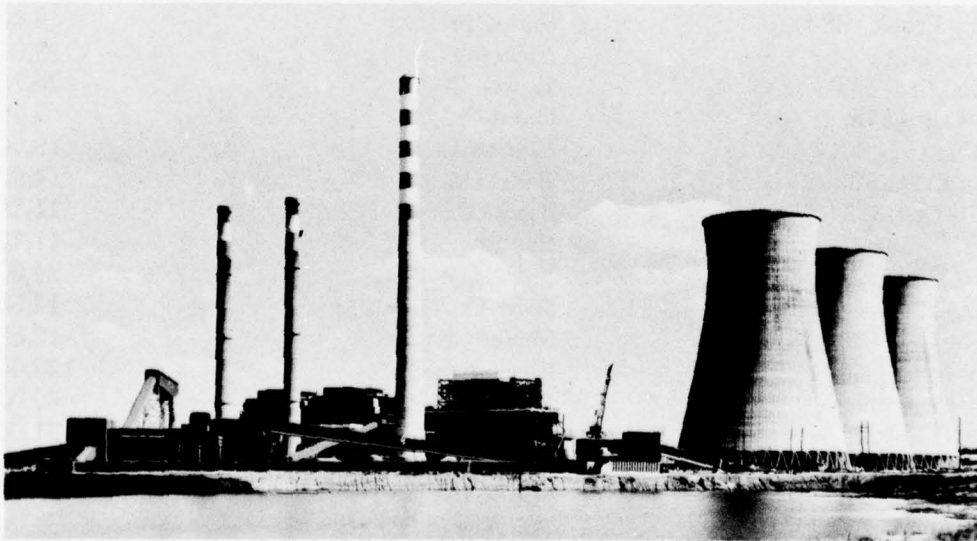
Early-action channel works consist of: (1) channel work for flood control and cropland drainage in 17 potential small watershed projects; (2) major channel works for flood control, with associated recreation development and environmental preservation, on Pudding and Tualatin

Rivers; (3) a basin-wide system of channel stabilization, as an essential adjunct to flood control operation of multiple-purpose storage projects; and (4) a separate project for channel stabilization on uncontrolled streams.

Nonstorage irrigation elements of the plan are portions of Federal and Federally-assisted projects which are for diversion (or pumping), conveyance, and distribution of an irrigation water supply. Sources of water include ground water; natural flows; and water from existing, authorized, assured, early-action, and long-range storage reservoirs. Total acreage expected to be irrigated under Federal and Federally-assisted projects would be about 549,000 acres.

Navigation elements consist of the authorized Willamette Falls Locks and open-channel works which, as a supplement to increased low-water flows, would provide increased depths for navigation in Willamette River upstream to the Corvallis-Albany area during the early-action period. No long-range additions are identified at the present time.

Power generation elements consist primarily of potential long-range conventional, thermal, and pumped-storage peaking installations.



A thermal plant using a hybrid cooling system.

Programs

Programs make up an important segment of the comprehensive basin study. Many of the ongoing programs would be accelerated during the early-action period to a level consistent with meeting rapidly growing needs.

Fish and Wildlife

The plan includes a three-part fishery program to continue the present fish production and fish stocking activities, provide for an increase in fish populations, and provide additional fishing opportunity. The fishery program has been developed in recognition of the national and international importance of the anadromous fish runs, and also because both resident and anadromous fish provide sport in the basin. Much of the fishery resource is supported by fish production and fish stocking programs: in fact, the resident trout fishery is maintained almost entirely by artificial propagation.

The specific programs in the early-action phase of the plan include hatcheries and impoundments for rearing both anadromous and resident game fish. The existing hatchery program would be supplemented by an extensive program for expansion and replacement of outdated hatchery facilities. This would provide anadromous and resident fish for pond and reservoir rearing programs and trout for sport fishing in reservoirs and natural and proposed artificial stream channels.

The plan includes compensation for the loss of natural stream channels due to reservoir construction and also to compensate for loss of access due to posting of private lands. Compensation could be through construction of artificial cold-water stream channels in suitable locations. About 300 miles of new channels would be provided in the early-action period.

A complementary program included in the plan is for State acquisition of access

sites to streams flowing through private lands. A total of 350 sites have been identified for acquisition by 1985. Access should also be provided to a number of isolated oxbow lakes, borrow pits, and low-elevation impoundments.

The plan includes continued research programs in the field of fishery management. Such programs are needed to develop improved techniques for fish production at lessened costs.

Preserving and increasing streamflow, improvement of water quality, and eradication of undesirable species are also part of the plan.

The plan includes a two-part wildlife program of research and education and increasing wildlife populations and hunter access. The program is primarily early-action to be accomplished by 1985.

Programs include those necessary to determine public preferences for and reactions to management and development programs. Also included is the public education to develop support for preferred programs. A second program in the plan is for prediction and evaluation of the effects of habitat manipulation, game harvest control, and other management of deer, elk, certain upland game, and migratory birds. This would be a computer simulation investigation.

The plan contains a provision for a major expansion of past acquisition practices. It would include securing certain unused or undeveloped flood plain lands with high potential for producing wildlife; leasing and development of about 23 pigeon springs; acquisition of three tracts on the valley floor for additional waterfowl refuges and nesting and feeding areas; contracts with landowners for access to farmlands and forest lands; and either adoption of a management plan to maintain constant levels of Fern Ridge Reservoir from May 1 to July 1 to enhance waterfowl nesting or development of a system of dikes for the same purpose.

Flood Control

The plan includes programs for reduction of flood damages through flood forecasting, small project construction, emergency action, and local flood plain zoning or land use regulation.

Flood forecasting is done under a streamflow program of the Weather Bureau in cooperation with the Corps of Engineers.

Small project construction is carried out under nationwide programs of both the Department of Agriculture and the Corps of Engineers.

The plan includes acceleration of the existing local flood plain zoning program to cover all of the remaining flood plain up to the 100-year flood level. Additional development and use of flood plain lands could then be made consistent with the degree of additional stage reduction by storage elements of the plan.

Irrigation

The plan makes provision for irrigation development through private initiative and investment. Estimates indicate that some 47,000 acres will be developed by the private sector during the early-action period. Recognizing shifts in land use, it is estimated there will be a net increase of 207,000 acres by 2020. Various programs of technical assistance, cost sharing, and loans are available to aid these individuals and small groups through agencies of the Departments of Agriculture and Interior.

Land Measures and Watershed Protection

Land measures programs, generally applied on individual ownerships of agriculture, forest, range, or suburban lands, include such practices as: seeding, tree planting, establishing sod waterways, streambank protection, channel improvement, drainage systems installation, reorganization of irrigation systems, erosion control, and sediment reduction from ponds and many others. The plan includes an acceleration of these programs to meet

needs on all the watersheds of the basin as well as those where early project action is contemplated.

The plan identifies a second type of land measure need which can be satisfied by small groups of landowners, generally two to six in number. Early action proposals of that type, totalling 172 in number, are included, which would provide for cropland drainage improvement, irrigation development, streambank and channel stabilization, and dike construction.

The plan also includes provisions for planning and application of an accelerated land treatment program in the 26 early-action small watershed proposals. An estimated 251,000 acres within these watershed projects will require treatment concurrently with the installation of structural measures, which were discussed in the preceding project section.

Forestry programs include such activities as reseeding, removal of log jams and debris from stream channels, road and trail restoration, erosion control, streambank stabilization research, and technical assistance.

In recent years an increasing load from sediment has been washing from developing areas around cities. Soil erosion increases dramatically on land being converted to suburban uses. This erosion and resulting sedimentation can be controlled with locally adopted modifications of soil and water conservation practices used successfully on lands of the basin.

Municipal and Industrial Water Supply

The plan does not include a specific water supply program. Projections indicate that the total available water supply from natural flows, ground water, and storage will be adequate to meet projected future needs. Since most of the additional needs are expected to be served from sources of lesser quality than presently used, the major problem of the future will likely be water treatment.

Navigation

The plan includes continuation at the present level of a program for Federal clearing and snagging to improve navigation. Because of the unpredictable nature of clearing problems, this program is applied on a case-by-case basis. No specific needs or costs have been identified.

Power

The plan does not include specific new programs for power. There is overall Federal-private coordinated planning to meet power needs which constitutes an on-going program. Research is underway as a part of this program to reduce both power costs and environmental impacts.

Recreation

The plan includes suggested agency responsibilities for recreation facilities to provide for more than 10 million recreation-days of use in the early-action program. This will require full use of the capabilities of the private sector and of local, county, state, and Federal groups and agencies.

The plan calls for a coordinating committee to be established either by the Oregon State Highway Department's Parks Division, consistent with its overall Parks Plan, or by the Bureau of Outdoor Recreation under its overall planning and coordination responsibility, or by both acting in cooperation. Membership should include all of the land management, water, and related resource agencies and one or more appropriate public representatives. Purpose of the committee would be to coordinate all of those aspects of recreation programs and activities which involve both governmental entities and the public.

There is a potential for a considerable degree of private development, particularly in the area west of Willamette River. The private program would be developed in consultation with agencies and representatives of local, State, and Federal government. This would be done through the

proposed coordinating committee. Private developments in the western portion of the middle and lower subareas would have a maximum of prospect for profit and a minimum of competition from recreation development on public land.

In general, city government programs could satisfy part of the high-density day-use needs. That responsibility will be highest west of Willamette River and in the middle and lower subareas, where the greatest needs now exist.

County programs should meet demands for neighborhood-community types of recreation and provide for day-use regional types of recreation within 1-hour travel distance from urban centers. Programs in counties with a maximum of recreation potential should be geared to attract use from out of county for economic stimulus and to help satisfy needs of other parts of the basin.

The State and local agencies should take action leading to the acquisition and development of areas that are: (1) near urban areas; (2) of high recreation and/or environmental quality, preferably associated with water bodies of high quality; (3) suitable for multiactivity and multiseason use; and (4) able to handle large numbers of people. Particular emphasis should be given the middle and lower subareas west of Willamette River. Much of the State emphasis should be on Willamette River, the Willamette River Parks System program, and connecting trails.

The State should encourage private-sector development through tax and liability incentives; technical, and possibly financial, assistance; and joint development of projects.

Federal construction and resource agencies also have responsibilities in the overall recreation program which, in general, requires accelerating existing programs for recreation planning and development to meet projected demands.

Water Pollution Control

The basic element of the water pollution control program is a high level of

at-source waste treatment by all municipalities and industries. At least 30 percent of that work, which constitutes an acceleration of an ongoing program, should be accomplished as soon as possible.

The construction cost of new treatment facilities would be the joint responsibility of private industry and all levels of government. Construction grants may be obtained, subject to availability of funds, from State and Federal sources for municipal treatment facilities.

There are many other elements of the overall program. These include: (1) flow regulation (augmentation), to the extent justifiable as a supplement to high levels of waste treatment; (2) completion of interceptor sewer facilities by the City of Portland; (3) control of wastes from houseboats and other watercraft including large ships; (4) control of fertilizers and commercial toxicants; (5) soil stabilization; (6) control of animal waste discharge to water bodies; (7) control of urban runoff; and (8) other management practices.

Environmental Management (Free-Flowing Streams)

A program of management, for preservation and protection of selected streams, stream reaches, and adjoining lands, is an important part of the plan. The purpose of the program is to give an increased level of protection against detrimental effects of increasing population and continuing developmental activities.

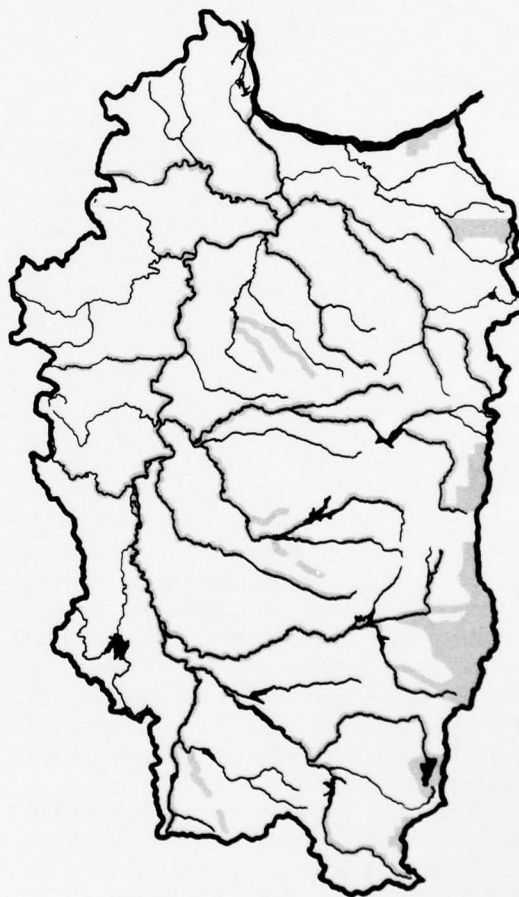
The proposed program would rely on State-originated action to preserve flows naturally available, or as can be provided from tributary storage. It would involve management of adjoining lands to protect scenic areas and preserve or enhance the overall streamside environment. Adjacent private landowners would be encouraged to maintain their land's natural and pleasing appearance.

The stream reaches recommended for inclusion in the program are listed in the

accompanying table. The extent of lands, along individual streams and reaches, which should be managed under the preservation concept would be determined by the inter-agency-local coordinating committee discussed in connection with recreation on the basis of land ownership; topography, as related to visibility from the stream; and overall character of the areas involved.

The program would not apply to those reaches of named streams which contain existing or authorized projects. Neither does it imply a recommendation for acquisition, condemnation, destruction, or removal of any existing development.

ENVIRONMENTAL MANAGEMENT



Streams selected for environmental management

<u>Subbasin and Stream</u>	<u>Exceptions</u>
<u>Willamette River</u>	Exist. project; early-action nav. channel mod.; basin-system channels; development of recreation potentials.
<u>1. Coast Fork:</u>	
Coast Fk. Will. R.	Exist. projects; early-action basin-system channels
Mosby Cr.	Long-range Abrams Reservoir
<u>2. Middle Fork:</u>	
M. Fk. Will. R.	Exist. projects; early-action basin-system channels
N. Fk. M. Fk. Will. R.	None
Diamond Peak Wilderness streams	None
Waldo Lake Rec. Area streams	None
<u>3. McKenzie:</u>	
McKenzie R.	Exist. projects; early-action basin-system channels
White Branch Cr.	None
Horse Cr.	None
French Pete Cr.	None
S. Fk. McKenzie R.	Exist. and auth. projects
Mt. Washington, Three Sisters Wilderness streams	None
<u>4. Long Tom:</u>	
None	
<u>5. Santiam:</u>	
Santiam R.	Exist. projects; early-action basin-system channels
N. Santiam R.	Exist. projects; early-action basin-system channels
L. N. Santiam R.	Early-action Lyons Reservoir
Breitenbush R.	None
S. Santiam R.	Exist. and auth. projects; early-action basin-system channels
McDowell Cr.	None
Wiley Cr.	Long-range Wiley Creek Reservoir
M. Santiam R.	Exist. project
Calapooia R.	Auth. Holley Res., including downstream channel
Mt. Jefferson Wilderness streams	None
<u>6. Coast Range:</u>	
Yamhill R.	None
Rickreall Cr.	Long-range Dallas Reservoir
Marys R.	Early-action Noon Reservoir

7, Pudding:

Molalla R.

Butte Cr.

Abiqua Cr.

Early-action Dickey Bridge Reservoir;
basin-system channels

None

None

8, Tualatin:

Tualatin R.

Early-action Gaston Reservoir;
Tualatin channel

9, Clackamas:

Clackamas R.

Eagle Cr.

Collawash R.

Mt. Hood Wilderness

and Rec. Area streams

Exist. projects; long-range Big Bottom
Reservoir; local FC under Sec. 205

Long-range Eagle Creek Reservoir

None

None

10, Columbia:

None

11, Sandy:

Col. Gorge Rec. Area

None

Local actions are underway to proceed with a basin-wide study of environmental potential and needs. The Columbia Region Association of Governments and the Mid-Willamette, Linn-Benton, and Central Lane Councils of Government, working with representatives of State government, industry, and other interests, are spearheading the action. The environmental management program of the comprehensive plan will be available to the local group for use in their study. The Willamette River Greenway Association is also active in developing the Willamette River Park System.

Supporting Services

The scope of supporting services will need to be increased as various elements of the comprehensive plan are implemented. Those services include the hydrometeorological reporting network, daily streamflow forecasting, seasonal water supply forecasting, and mapping programs. In addition, air pollution control support can be provided in conjunction with the hydrometeorological reporting network, and radar weather

surveillance, soon to be completed, will add to the daily streamflow forecasting capability.

Of particular importance to the plan is the hydrometeorological reporting network. As early-action storage elements of the comprehensive basin plan are constructed, additional precipitation reports will be needed to determine reservoir inflow at the individual projects. A completely automated, computer-readout hydrometeorological reporting system (snow data, river stage, water temperature, soil moisture, precipitation, air temperature, wind, etc.) has been planned for Willamette Basin as part of a multiagency Columbia River Basin Network and is programmed for installation by 1975. The automated network of snow data stations is also being expanded. Essential segments of the existing Willamette Basin telemetered and nontelemetered networks could then be combined into the multiagency Columbia River Basin Network, on a cost-sharing basis, with data retrieval possible for all interested parties.

WHAT THE PLAN WILL DO

Implementation of the comprehensive plan would bring about changes in each of the recognized functional areas of flood control, irrigation, power, navigation, municipal and industrial water supply, fish and wildlife enhancement, recreation, and water pollution control. It also would have a significant impact on the broader areas of land measures and watershed protection and the total basin environment. The following is a summary of the impacts of the plan.

Fish and Wildlife

Under the plan, increased low water flows of good quality would be provided for fish. In concert with programs for at-source treatment or elimination of waste and with completion of Willamette Falls fish passage facilities, those flows would permit anadromous fish to migrate both upstream and downstream at all appropriate times of the year. Since fishery enhancement would become one of the recognized purposes of the storage projects, these would be operated to provide desirable flows, particularly in late summer and fall. A portion of those increased flows would be used to provide attraction and transportation flows for the fish ladder at Willamette Falls.

Project facilities to permit rearing of anadromous juveniles in certain reservoir pools, plus the necessary techniques that now are being developed and tested at Fall Creek, Green Peter, and Cottage Grove Reservoirs, will result in a major increase in fish production.

The effect of the comprehensive plan on anadromous fish resources would be to offset and mitigate losses and to significantly enhance the resource. The fishery agencies are optimistic that the plan would meet much of the sport and commercial fishery demand and also contribute addi-

tional supplies to national and international markets.

Effects of the basin plan on resident game fish would be less significant than those on anadromous fish. Project construction would reduce stream spawning, rearing, and fishing potentials for trout. Reservoirs would provide an extensive still-water fishing potential as a substitute for stream areas lost. With an adequate stocking program, the result could be an increase in number of fishermen accommodated, and possible an increased level of success, as compared to the present stream fishery. However, the substitution of a reservoir fishery for the stream fishery would represent a loss in the opinion of many fishermen. Proposed new fishing channels could offset that loss. Improved access to streams and stream reaches now little used could add to resource utilization and, with adequate stocking, help to maintain present success levels in the future. Warm-water fish, which generally are in adequate supply, would be little affected by the plan.

It appears that the effects of the plan on wildlife would be minor, but probably detrimental overall because of loss of habitat. Some big game habitat would be lost in each of the major reservoirs. Small game, upland bird, and some big game habitat would be lost in most of the small reservoirs. Waterfowl habitat would be relatively unaffected by reservoir construction. Channel improvements for flood control and drainage must be undertaken with full knowledge of the effects on wildlife to prevent considerable loss of habitat.

Measures to compensate for losses to wildlife, in connection with individual projects, would be developed by the construction agency involved, in cooperation with the Oregon State Game Commission and the Bureau of Sport Fisheries and Wildlife. However, an overall loss of habitat probably cannot be avoided. Depending on



Pond planted to corn or sudan grass each year to attract waterfowl.

crops raised and crop practices, upland game might benefit from food supplies developed incidental to irrigation. Waterfowl would benefit from water level management in Fern Ridge Reservoir and from provision of assured water supply for certain refuges and management areas. Program and management elements of the plan should result in some increase in usable wildlife habitat, improved or increased hunter access to wildlife populations, and an opportunity for improved distribution of use commensurate with resource availability.

Flood Control

Proposed structural and nonstructural flood control measures would reduce present and future flood damages on the basis of present development. The structural measures would prevent or reduce damage to lands, and to such developments as

might be made on flood plain lands. In addition, increased use could be made of flood plain lands and damages to the additional development involved would be prevented or reduced.

The proposed plan includes 790,000 acre-feet of early-action flood control storage upstream of Willamette Falls. Of that, 352,000 acre-feet would be effective at the falls in the control of the 100-year flood. Early-action projects would add 1,023 square miles of area control. Those projects above Salem would reduce the stage of the 100-year flood at Salem by 3.5 feet.

By 1980, the early-action projects would prevent \$2.9 million of average annual flood damages and would permit approximately \$2 million in increased land use. The early-action projects would satisfy about 19 percent of the residual storage needs above Willamette Falls and eliminate about 41 percent of the damages projected for 1980. The additional projects in the

long-range segment of the plan would provide about 12 percent of the storage still needed after early-action projects would be in operation. Total damage prevention benefits for long-range projects would approximate one-third of the residual. Overall, the plan would provide 62 percent of the 100-year flood control storage need.

Structural measures alone, however, would foster a false sense of security and encourage unwarranted encroachment on the remaining flood plain. Thus, local regulation of flood plain use must be put into effect if the plan ultimately is to accomplish more than a temporary reduction of potential flood damages. Flood plain regulation could also provide open space which will be needed in the future.

Adverse effects, or impacts, of the flood control portion of the plan include: loss of productive forest and agricultural lands in reservoir areas; environmental losses at project sites, offsetting some of the multiple-purpose environmental improvement in the flood plain; some loss of free-flowing streams for fish spawning and rearing and fisherman use; and loss of wildlife habitat, in reservoir areas, for which no total offset is available.

Irrigation

The plan includes private, Federal, and Federally-assisted developments to meet irrigation needs.

Private developments include those by individuals and small groups utilizing natural flows, farm ponds, ground water, and storage. The private segment of the plan would result in a net increase of about 207,000 irrigated acres.

Federally-assisted actions embodied in Public Law 83-566 small watershed proposals would place an additional 59,000 acres under irrigation during the early-action period and another 6,000 acres in the long-range. About 9 percent of that

acreage could be irrigated with storage in existing and authorized Federal reservoirs as a single-purpose alternative to construction and use of multiple-purpose storage within the watershed. Local decisions will determine action on those alternatives.

Federal project-type irrigation development in the plan would place an additional 461,000 acres under irrigation. One of the reservoirs included in that development could be constructed under either the Public Law 83-566 or the Public Law 84-984 program. Local decisions will determine actions on those alternatives.

In total, the irrigation plan provides for irrigation of 733,000 acres of land. Adding this increment to existing (244,000 acres), authorized, and assured (23,000 acres) development results in a total irrigation development of 1,000,000 acres by 2020.

A portion of the water reserved for irrigation in existing and authorized Federal reservoirs would be utilized during the early-action period. A net increase of about 72,000 acres is expected to be irrigated from that source. A considerable amount of additional storage in those reservoirs would be available for irrigation under existing authorizations and a large portion is expected to be used for that purpose in the long-range period. However, consideration should be given to the possible reassignment to other functions of any portion of storage not needed for irrigation. Further studies will be needed to identify amounts and locations.

New storage sites in the early-action plan will provide additional water for irrigation use. However, with only minor exceptions, new storage is proposed to irrigate only those lands which cannot be supplied economically from existing and authorized reservoirs.

Irrigation in the plan would have a profound effect on the basin's economy. Irrigation provides the opportunity to grow a wider range of crops and the means for intensifying production on the individual

farm. Irrigation can and should make maximum contribution to the basin's livability. The esthetic impact of lush green irrigated fields is sure to enhance the environmental aspects of the basin.

Adverse effects, or impacts, of the irrigation plan would be minor. Reservoir effects would be as discussed for flood control. Increased irrigation development would be to the detriment of some forms of wildlife, but for others it would provide a source of additional food supplies. Return flows from irrigation could be detrimental to water quality, but proper management would prevent wasteful overland return flows. Further research on agricultural chemicals will reduce the possibility of return flows degrading water quality.

Land Measures and Watershed Protection

Various early-action programs for land measures and watershed protection have as basic goals: (1) the protection of soil values and (2) the restoration and preservation of stable hydrologic conditions on the watersheds. Achievement of those goals would keep basin lands in a state of readiness to meet demands imposed by changing land use. It would help to insure that the quality of water emanating from basin land is acceptable for all uses. Other effects would include the improvement of fish and game habitat and development, by research, of new knowledge to improve soil and water management.

The plan will meet 86 percent of private land treatment and 100 percent of the watershed land treatment needs as projected for 2020.

Overall, the proposed programs, ongoing, accelerated, and new, would meet most of the needs associated with those goals if carried out at the scale proposed. The cost of program measures generally would be more than offset by preventing

soil loss, deterioration of water quality, and loss of fish and game habitat.

Municipal And Industrial Water Supply

The early-action elements of the plan include about 50 new Federal multiple-purpose reservoirs, distributed among nine of the eleven subbasins. A majority of those reservoirs would be located in the area west of Willamette River. The stored water which would be available to alleviate summer water shortages in that area could contribute substantially to municipal and industrial needs.

The plan elements would satisfy substantially all M&I needs as projected for 2020. Nonetheless, public education as to the availability and effects of newly developed water treatment techniques probably would be necessary to obtain public acceptance of some available sources.

Navigation

The effect of navigation proposals in the early-action portion of the plan cannot be fully evaluated until more detailed studies permit a decision as to both the depth and upstream terminus for a navigation channel. Possible adverse impacts of any finally selected plan would be principally on fish life, and possibly wildlife and natural environment. Fish life impacts would be the adverse effects of channel dredging on spawning and rearing areas and, to a very limited degree, on turbidity levels during dredging. Plans for extent, timing, and disposal of material from dredging would have to be developed in cooperation with fishery and recreation agencies.

Power

The study revealed only a modest potential for additional development of conventional hydropower generating in-

stallations. Some of that potential was excluded from the plan under the environmental management program; the balance was either not economically feasible or deferred for long-range development.

Non-Federal development of thermal generating plants during the early-action period could be of considerable significance. Such development could provide a substantial increment of energy to meet increases in base load. Also, energy available during off-peak periods would support development of pumped-storage installations which could meet peak loads on the system.

Thermal generating plants, whether fossil-fueled or nuclear-fueled, have the potential for severe adverse effects on air or water quality, or both. The study showed the potential load by 2020 would require 49,000 megawatts of thermal plant capacity. Public acceptance of siting and/or safety of nuclear-fueled plants may pose problems. Research now underway by Oregon State University, Eugene Water and Electric Board, and Weyerhaeuser Company may lead to developing methods for beneficial use of warmed cooling water from thermal plants.

Recreation

The plan would enhance outdoor recreation in the basin. Proposed facilities and continuation of ongoing programs would go far toward meeting present and future needs. Because of the location of population centers with respect to proposed projects and resources, there would be some lack of balanced distribution of recreation opportunities. Proposed agency-public action, however, would work to improve that situation, particularly for areas west of Willamette River.

Recreation facilities at existing, authorized, assured, and early-action projects would provide for roughly 6.3 million recreation-days of use by the end of the

early-action period. Additional facilities would be provided to satisfy increasing demand after the early-action period.

The overall plan would meet 127 percent of the 2020 projected need for resource capacity and 117 percent of the need for recreation facility development. Because of the distribution of the resources and the facilities there would still be a shortage in the lower subarea.

The impact of proposed projects and programs on recreation varies from beneficial to possibly highly detrimental. Proper planning, construction, operation, and maintenance will be essential for all projects if the overall effects on recreation are to be beneficial. Ongoing and proposed new programs, particularly those for land treatment, watershed protection, and environmental management, generally would enhance outdoor recreation. Irrigation would enhance the appearance of agricultural areas. Some parts of irrigation conveyance and distribution facilities offer the possibility of scenic trails. Increased streamflows would enhance the value of streamside recreational programs. This would be particularly true on Tualatin River and other west side streams which now suffer severe water shortages during the recreation season. However, enhancement attributable to increased flows could be offset by the detrimental effects of inadequately planned and executed channel work and bank stabilization. Planning and construction must give proper consideration to esthetics.

Water Pollution Control

The basic requirement for control of water pollution is at-source treatment of wastes. Also, erosion and accompanying sedimentation must be reduced through adequate land treatment practices. However, some of the polluting effects of a growing population and its activities are not readily subject to control or treatment. Therefore, there is a need for increased

flows to dilute the remaining pollution load. This is particularly true in the Portland Harbor area. The existing, authorized, and early-action storage could provide most of the flow augmentation needed.

The planned water quality improvement is reflected in the projections of substantially increased anadromous fish runs, as well as in the planning for recreational development on Willamette and Tualatin Rivers. If this improvement in water quality is not realized, the principal value of those planned improvements would be lost.

Environment

Both programs and projects in the plan would have a significant impact on the basin's environment. The degree of impact is only partially known. The detailed environmental studies which will precede implementation will be aimed at determining this degree of impact.

Willamette Basin lands are about two-thirds forested. Half of the forested lands are in public ownership, administered principally by the U. S. Forest Service and the Bureau of Land Management. Thus, the land treatment and watershed protection programs of those agencies would affect about one-third of the total basin area. The programs are aimed at restoring desirable conditions and keeping basin lands in a state of readiness to meet growing and changing needs. They include fish and wildlife, recreation, and environment, as well as timber production and harvest, and other multiple-use functions. For those reasons, implementation of the plan would go far toward improving overall environmental quality and maintaining those aspects which now are desirable. Similarly, most of the land treatment measures and programs for agricultural areas would tend to improve the environment.

The proposed environmental (free-

flowing) management program would provide for protection of flows, water quality, and natural streamside environment. It covers all but excepted portions of 29 streams, plus all streams in five wildernesses and three designated forest recreation areas. On those named streams, it covers more than 1,250 miles of natural channel and the immediately adjoining lands. Implementation would protect natural conditions against immediate change and provide a basis for reasoned choice in the future. However, the program, as proposed, represents less than the recommendation by the Recreation Committee. Some of the projects for which exceptions were made would have partially offsetting beneficial effects on streamflows and water quality, and all would be planned to minimize adverse effects.

Fish and wildlife programs would both maintain and improve environmental quality and provide for increased use and enjoyment of the resources.

The effect of construction of projects would be to cause a change in natural environment at the project site or in the project area. Structural elements listed for early-action, as described, incorporate provisions for minimizing adverse impact and provision for fish and wildlife and recreational functions. In planning, constructing, and operating projects—particularly extensive channel improvements and potential pumped-storage projects—construction agencies and the private sector must recognize the potential for adverse effects on the natural environment and take steps to avoid it. On the other hand, the overall effects of reduced flood damage, increased streamflows, and improved water quality would be beneficial to the basin environment. Provision of mass recreation facilities at reservoirs would tend to reduce pressure on, and delay over-use and damage to, more fragile natural environment.

Projected 2020 needs and comprehensive plan accomplishments

Functions to be Served	Needs ^{1/}		Percent of Satisfaction ^{2/}
	Units	Amounts	
<u>Fish and Wildlife:</u>			
Fish:			
Spring chinook salmon	Number of fish	538,000	46
Fall chinook salmon	" " "	1,148,000	80
Coho	" " "	644,000	42
Summer steelhead	" " "	269,000	12
Winter steelhead	" " "	24,000	65
Trout	" " "	5,500,000	122
All warm water	" " "	1,500,000	36
Wildlife:			
Big game	Hunter-days	1,978,000	44
Upland game	" "	1,958,000	69
Waterfowl	" "	603,000	56
<u>Flood Control:</u>			
Annual flood damages	Aver. ann. dollars	213,500,000	33
Effective <u>3/</u> storage	Acre-feet	4,005,000	62
<u>Irrigation:</u>			
Water supply	Acre-feet	2,460,000	100
Area irrigated	Acres	1,000,000	100
<u>Land Measures & Watershed Protection:</u>			
Private land treatment	Acres	4,585,000	86
	Dollars	308,000,000	85
Watershed land treatment	Acres	562,000	100
	Dollars	30,200,000	100
<u>Municipal & Industrial Water Supply</u>	Acre-feet	1,613,700	100
<u>Navigation:</u>			
Wood chips	Available tonnage	2,697,000	34
L.P. gas	" "	35,000	100
Greases	" "	50,000	100
Asphalt	" "	369,000	100
Agricultural chemicals	" "	595,000	100
<u>Electric Power:</u>			
Firm energy	Million kilowatt-hours	457,000	100
Peak load	Kilowatts	91,800,000	100
<u>Water-Related Recreation</u>			
Resource capacity	Recreation-days	60,592,000	127 ^{4/}
Facilities	" "	60,592,000	117 ^{4/}
<u>Water Pollution Control</u>	Flow, cfs ^{5/}	7,500	91

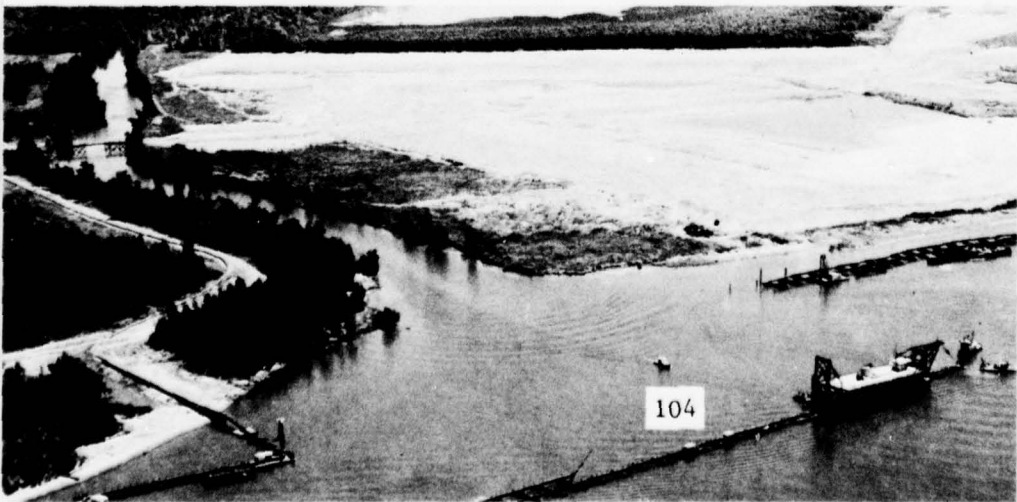
1/ Summarized from appendixes.

2/ To the degree identified.

3/ Effective downstream from mouth of Clackamas River; includes need for 305,000 acre-feet on that stream.

4/ Basin arithmetic total; there would be a shortage in the lower subarea.

5/ For Willamette River in Portland harbor area in August.



SUBBASIN SUMMARIES

The purpose of the following discussion of the plan by subbasins is to show how plan elements relate to particular areas of the basin.



Coast Fork Subbasin

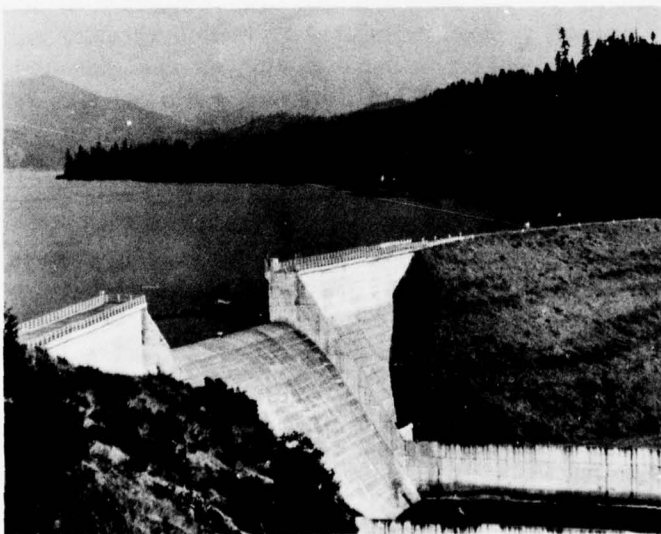
The Setting

Coast Fork Willamette River drains an area of 665 square miles of the northern slope of the Calapooya Mountains. It is a region of rugged foothills and low mountains; a decidedly rural landscape where more than 80 percent of the land is commercial forests. Rivers and streams are characterized by a wide range between winter and summer flows. The area is heavily dependent on timber processing as the economic mainstay. Although there is

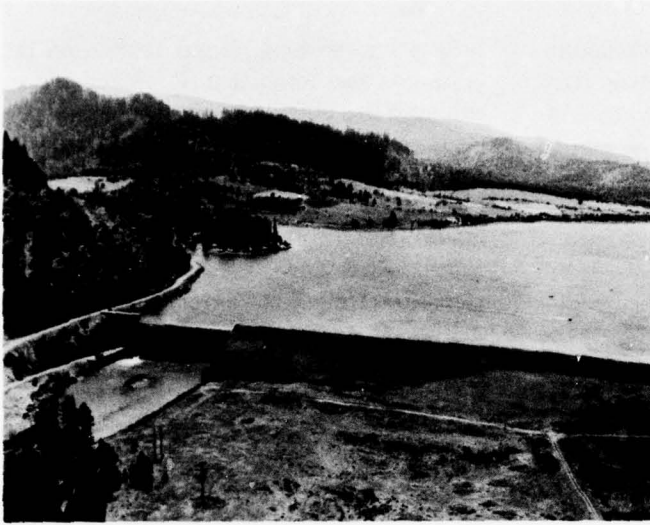
only a limited agricultural base, food processing is also important. Population of the subbasin in 1960 was 17,000.

It seems reasonable to expect that Coast Fork Subbasin will continue to retain its essentially rural character, except in the lower elevations adjoining the growing Eugene-Springfield urban center and adjacent to the interstate freeway. Projections indicate a tripling of population over the next 50 years, but still a density of only 89 persons per square mile. The majority of the population growth will likely be in or adjacent to present population centers.

The existing Federal reservoirs, Dorena on Row River and Cottage Grove on the Coast Fork, are authorized for flood control and to store water for navigation and irrigation. Some recreation facilities have been provided. Those reservoirs cannot provide optimum fish flows at Goshen. *Neither could they provide minimum fish flows after about 1980 if irrigation demand increases as expected.* High streamflow temperatures downstream from the dams during the late season cannot be significantly improved by modification of existing structures. Additional storage is re-



Dorena Reservoir, on Row River, is authorized for flood control and water storage for navigation and irrigation.



Cottage Grove Reservoir is on Coast Fork Willamette River - built for flood control and to store water for navigation and irrigation.

quired to provide for a resident trout fishery, lower water temperatures in streams, and an irrigation supply for the Camas Swale Game Management Area.

The existing reservoirs provide only about one-half of the effective storage required to control a 100-year flood at Goshen—about 100,000 acre-feet of additional storage space, properly located upstream, would be required for that purpose. Neither do they control runoff from enough of the watershed to achieve a high degree of flood control at Goshen. As a consequence, average annual damages of about \$205,000 are expected to more than double by 2020. Mosby Creek is the only large tributary with no storage control, so storage should be considered for that stream. Since neither of the existing reservoirs is large enough to control a 100-year flood at the site, enlarging them or providing additional storage upstream will be required. Channel stabilization is needed downstream from the dams to facilitate reservoir operation for flood control.

Available ground water supplies, together with authorized irrigation use of the existing Federal reservoirs, would be adequate in quantity to meet projected irriga-

tion requirements although some locational deficiencies exist. Unless other uses are found for existing storage, both sources should be utilized to the maximum extent practicable before additional Federal funds are expended for irrigation storage.

Existing sources of municipal and industrial water supplies appear nearly adequate to meet 2020 needs. Cottage Grove will require a small amount of additional storage, and Creswell will need to acquire additional water rights.

Surpluses in both water-related and nonwater-related recreation capacity will exist within the subbasin until sometime after 2000. However, additional facilities will be required by 2020—enough to provide 2,848,000 additional recreation days of use annually. Also, the Recreation Committee recommends that Coast Fork Willamette River, except for existing projects, and Mosby Creek be left in natural conditions.

Because flows required for water quality purposes are considerably less than other minimum flow requirements, additional storage is not needed specifically for water quality control in the subbasin.

The Plan

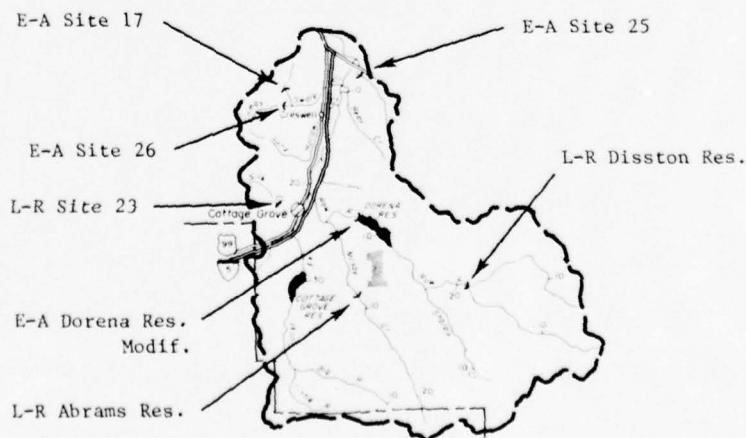
There appears to be no potential in the subbasin for power development, or for navigation other than the release of stored water. There are, however, significant sub-basin storage needs for flood control and enhancement of fish flows. Basin-system studies show major downstream needs for flood control and for multiple-use flow augmentation. Those needs could be partially satisfied by additional storage development. A locally-instituted program to regulate flood plain use would be an essential adjunct to storage, to prevent future increases in flood damage potential. Plan elements are presented following.

Early-action plan elements. - Early-action features would help meet both subbasin needs and downstream requirements. The principal measures include modification of the existing Dorena Dam and Reservoir and construction of two small watershed projects. At Dorena Dam, gates would be provided in the spillway to permit controlled use of an additional 10,000 acre-feet of storage space for flood control. The two watershed projects, located in the Camas Swale and Cloverdale areas, would include three reservoirs with a total capacity of 31,400 acre-feet. Those projects would also provide necessary land treatment measures, about 4.3 miles of

channel work, and an irrigation distribution system for 3,200 acres of land. These watershed plans provide 6,850 acre-feet of storage for which no specific use is identified; further studies will be required to identify the needs for this water or to modify reservoir plans.

The reservoir in the Cloverdale project would provide irrigation service alternative to use of upstream Federal storage authorized and presently available for that purpose. If that source were used, the reservoir probably could not be justified. Final decision on the irrigation alternative ultimately will be made by local interests.

Other features of the early-action plan include: (1) channel modifications to permit efficient operation of subbasin reservoirs for flood control, (2) additional irrigation facilities through private development, (3) a local program of flood plain use regulation, (4) installation of six small group-enterprise jobs on agricultural land, (5) soil and water restoration measures at 33 locations on O&C forest lands, (6) a proposed environmental management program for Coast Fork Willamette River and Mosby Creek, with exceptions for existing development, proposed channel modifications and a long-range reservoir on Mosby Creek, and (7) reauthorization of both Dorena and Cottage Grove Reservoirs to include the functions of fish and wildlife,



recreation, and others as appropriate.

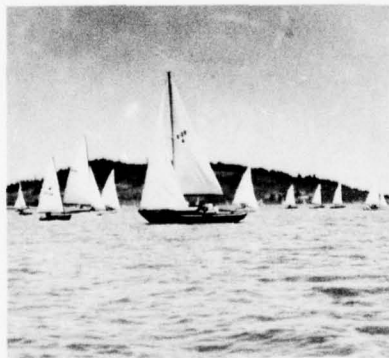
Long-Range Features. - During the long-range period, development would be directed principally toward meeting projected increases in needs for flood control, fish and wildlife, and recreation.

Even though Mosby Creek has been suggested for inclusion in the environmental management program, storage on this stream is essential if flood control goals are to be achieved. Therefore, a 50,000 acre-foot reservoir at the Abrams site is included as a long-range plan element. In addition to providing flood control, the reservoir would improve fish habitat downstream through increased flows and temperature control.

The most effective way to meet a majority of the remaining needs in the

subbasin would be to provide storage on Row River above Dorena Reservoir. The long-range plan includes a 90,000 acre-foot reservoir at the Disston site, primarily for flood control and fish life.

Other features included in the long-range plan include: (1) a small (7,900 acre-foot) reservoir on Silk Creek primarily for irrigation, (2) about 20 miles of tributary channel work for flood control and drainage, (3) additional private irrigation development, (4) water treatment facilities, (5) additional recreation facilities, (6) expansion of the Camas Swale Game Management Area by about 2,000 acres and provision of a water supply, and (7) additional channel modifications on the Coast Fork and major tributaries.




Recreation needs must also be recognized in future planning.

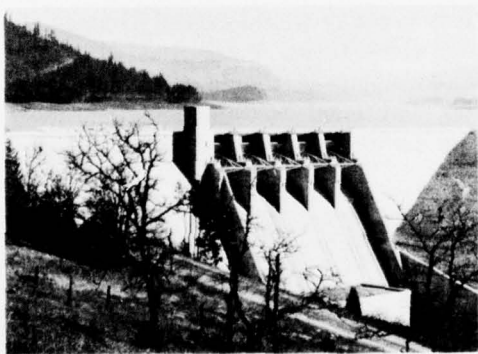



Middle Fork Subbasin

The Setting

Middle Fork Willamette River heads at Timpanogas Lake in the Cascades, drops into Hills Creek Reservoir, rushes through Black Canyon, slows through Lookout Point and Dexter Reservoirs, and joins with the Coast Fork near Springfield. The area drained is relatively steep, three-quarters forested, dotted with lakes and alpine areas in the upper regions, and only two percent in agriculture.

Hills Creek Reservoir. 




Dexter Reservoir. 

The population, which in 1960 was 9,400, is concentrated in the extreme lower end of the subbasin. The economy of the area is almost wholly dependent on timber harvest and recreation.

The present water and related land resource development includes, in addition to the three reservoirs mentioned, Fall Creek Reservoir which, like the other three, is also an element of the existing Willamette Basin Project. There are channel improvements, bank protection works, fish hatcheries, 2,100 acres of irrigation, land and watershed management programs, and a variety of recreational developments.

In the future, the subbasin is expected to remain a forest-oriented area. Its great recreation potential no doubt will be utilized; however, with 90 percent of the land in National forest, most of the development will be consistent with multiple-use concepts of forest management.



 Lookout Point Reservoir.



Existing storage facilities are authorized for flood control; navigation; irrigation; and, except for Fall Creek, power generation. When operated under the existing authorizations, Hills Creek and Lookout Point can provide minimum fish flows on the Middle Fork through 2020 with only minor shortages. Satisfaction of optimum requirements after 1980 would require additional storage. Fall Creek Reservoir presently is drawn down early each summer to meet downstream navigation needs. Under those conditions, it can only provide near-minimum flows during the latter part of the low-water season. The Lookout Point Reservoir project blocks fish passage, and a holding pond, egg-taking facilities, and hatchery facilities have been provided. Proposals to trap and haul adult anadromous fish to upstream spawning areas hinge on determining a feasible means of transporting downstream migrants around or through Hills Creek, Lookout Point, and Dexter Reservoirs. Natural production of warm-water game fish in the subbasin is expected to keep pace with future demands, but accelerated fisherman-access programs will be needed to maintain a balance between demand and available supplies.

Specified wildlife needs are minor with only a recommendation for acquisition and development of land at a "pigeon spring" to enhance bandtailed pigeon habitat.

Annual flooding occurs on only about

500 acres in the entire subbasin. Existing storage facilities are adequate to control a 100-year flood at Jasper. A total of about 11 miles of channel improvement is needed on the Middle Fork and Fall Creek to facilitate reservoir operation for flood control. In addition, about 5.5 miles of channel improvement is needed on minor tributaries in the subbasin.

Present irrigation development in Subbasin 2 is relatively small; only about 2,100 acres are irrigated. Even with the projected threefold increase in irrigation between 1965 and 2020, there are abundant water supplies available to meet the needs. Storage in existing Federal reservoirs, and ground water, can easily meet the projected irrigation requirements; however, small amounts of additional storage would be desirable to provide a more economical supply for some locations.

Municipal and industrial water rights and supplies appear adequate to meet 2020 demands. The town of Lowell will need to supplement its municipal water supplies by 2020; existing Federal reservoirs provide an available source.

Present recreation facility capacity would satisfy only about one-third of the projected demand by 2020, but water-surface capacity would exceed demands by nearly three times. Water-oriented recreation development should emphasize providing additional facilities and improving access to the facilities. The Recreation

Fall Creek Reservoir. ◇



Committee recommends that Middle Fork Willamette River and the North Fork of the Middle Fork be left in natural condition under an environmental management program.

Flows recommended for pollution control within the subbasin are negligible; however, needs exist downstream on Willamette River which will require at least the continuation of present releases from existing reservoirs.

The Plan

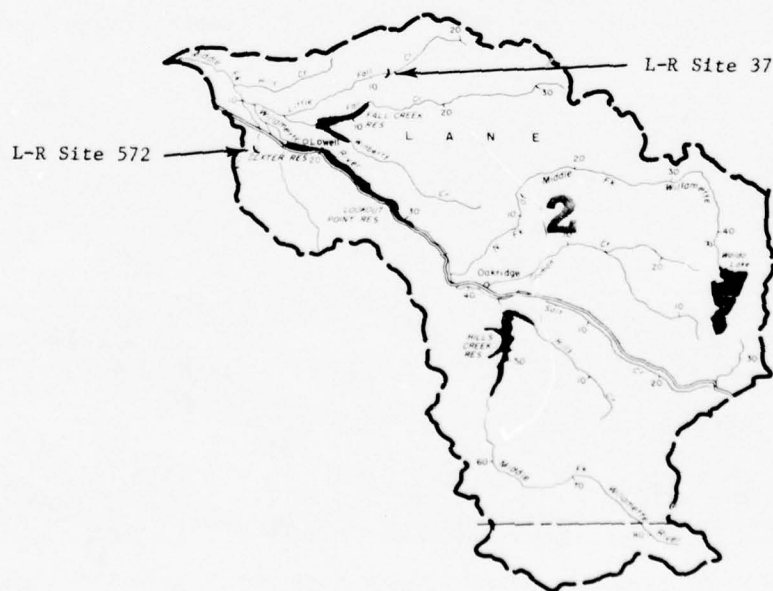
There is little need, in the subbasin, for additional multiple-purpose storage. However, existing projects can be operated to insure increased flows for fish life. Also, additional recreation and irrigation facilities can be provided, and some watershed improvement work can be done on minor tributaries. Features of the plan are presented following.

Early-Action Plan Elements. - Early-action features include one small watershed project and several miscellaneous items. The watershed project would be provided on Rattlesnake Creek to serve flood control

and irrigation needs. Flood control works would consist of 3.5 miles of channel modification and 1,800 feet of dike. A distribution system to serve 800 acres would also be provided.

Other features of early-action plan include: (1) channel modifications to facilitate operation of the reservoirs for flood control, (2) acquisition and development of lands at a mineral spring, (3) irrigation development by private enterprise, (4) additional recreation facilities, (5) a local program of flood plain use regulation, (6) the proposed environmental management program for Middle Fork Willamette River and the North Fork of Middle Fork Willamette River, (7) installation of five small group-enterprise jobs on agricultural lands, and (8) soil and water restoration measures at 14 locations on O&C forest lands and at 44 locations on National forest lands.

Long-Range Features. - Even beyond the early-action period there appears to be little need for water resource development in the subbasin. Two small reservoir projects are contemplated—one on Rattlesnake Creek and one on Little Fall Creek—primarily for local flood protection. They



would have a total capacity of 22,800 acre-feet. Other features included in the long-range plan are: (1) about 7.5 miles of channel modification on the Middle Fork and major tributaries, (2) 2 miles of channel work on minor tributaries, (3) recreational facilities to accommodate a considerable increase in use, and (4) irrigation facilities to serve about 4,000 additional acres.



McKenzie Subbasin

The Setting

McKenzie River, flowing from Clear Lake in the Cascades to Willamette River near Coburg, drains a region which varies from glacier-flanked mountains to orchard lands, to subdivisions. Most of the area is mountainous forest land. The McKenzie economy is heavily dependent upon har-

vesting and processing of forest products; on tourism; and, in the Eugene-Springfield area, on light manufacturing, and service industry. The population, which is concentrated in the lower, western portion of the area, was 21,500 in 1960.

The McKenzie area is, to many people, western Oregon at its best, with rushing white-water streams, forests, lava flows, alpine meadows, snowcapped mountains, lakes, hiking trails, wilderness, and solitude. With the Eugene-Springfield metropolitan center as a base and the best of outdoor livability close at hand, it seems likely that there will be much growth and development here. Population projections indicate that, over the next 50 years, the number of people will triple. Most development no doubt will come in the western end of the subbasin and, to a lesser extent, along McKenzie River. Federal ownership of more than 70 percent of the land will insure that the region will retain its basic character.

Existing and authorized development in the subbasin includes three multiple-purpose storage projects, a municipally-owned water and electric power system, considerable recreation lands and facilities, one small watershed project, and some



Looking into the McKenzie River Valley from Horsepasture Mtn. trail.

development under land and watershed programs.

The Recreation Committee has recommended that certain streams be maintained in their natural condition, under an environmental management program. The streams involved are McKenzie River; South Fork McKenzie River; White Branch, Horse, and French Pete Creeks; and all streams in the Mt. Washington and Three Sisters Wildernesses. There are sites available on some of those streams for possible multiple-purpose and single-purpose projects, and for development of pumped-storage power generation.

Recreational capacity of water-surface areas in and immediately adjacent to the subbasin is more than adequate to meet projected 2020 needs. Lack of surface area at the place of need may make a small amount of additional water-surface area desirable, particularly in the day-use zone of the Eugene-Springfield area. Existing recreation facilities will be adequate to meet the demands until after 2000, but between 2000 and 2020 facilities must be constructed to provide for nearly 1 million additional recreation days of use.

Other recreation-oriented needs which should be considered for early action include: (1) improved access to, and protection of, unique wilderness, botanical, geological, and scenic areas; (2) additional scenic and general access roads and trails; (3) additional boat access to McKenzie River; and (4) a review of historical features to permit establishment of an interpretive program.

Anadromous fish needs are for increased flows of good quality water, and for passage around man-made and natural migration barriers. No water temperature problems are apparent, although there are indications of project-caused low temperatures or other factors which interrupt upstream migration of adult fish.

Optimum and minimum fishery flows

cannot be provided by presently scheduled operation of existing and authorized storage. Wildlife needs, as in most of the other subbasins, are for additional and improved habitat and hunter access.

Flood control needs of the subbasin are relatively small, except along the lower reaches where high-value agricultural lands and encroaching urban developments are subject to damage. Existing development, however, provides less than one-half of the effective storage needed to control a 100-year flood at Coburg. As a consequence, an annual average of about 1,100 acres are inundated by floods. Resulting average annual damages amount to about \$350,000, and are projected to nearly double by 2020 if no additional measures are taken. McKenzie River floods contribute substantially to damage along all of Willamette River downstream.

Local works, needed to supplement substantially any degree of storage control, would consist of channel improvement. The principal needs are to stabilize the confluence of McKenzie and Willamette Rivers and about 19,000 feet of banks and channels, and provide and maintain channel capacity adequate to confine flood control storage evacuation flows to the channel.



1964 Flood - McKenzie River.

Irrigation in the subbasin presently relies on natural flow, farm ponds, and ground water as sources of supply to irrigate about 7,800 acres. Projections indicate that irrigated lands will increase to about 12,000 acres by 2000 and then decline to about 10,000 acres in 2020 as agricultural lands are converted to urban use.

Most of the irrigable lands in the subbasin are close to available water supplies from streams, small ponds, and ground water. Those lands probably will be irrigated on an individual basis. There is an area in Mohawk River Valley where about 1,000 acres could be developed on a project basis if storage could be justified on that stream.

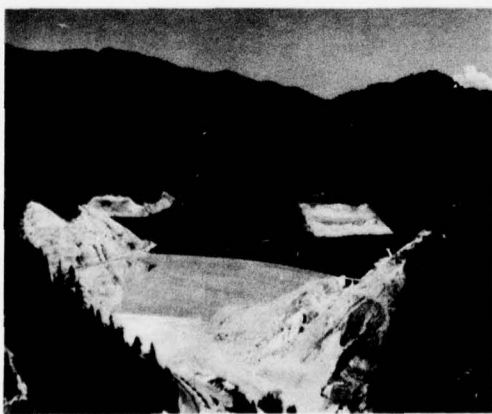
The municipal and industrial water supply needs which must be considered include those of the small communities within the subbasin and those of the Eugene-Springfield service area, most of the latter being located outside of the subbasin. The smaller communities are expected to expand the use of the present ground water and natural flow sources and should have no serious problems in meeting their projected needs.

Most of the municipal and about two-thirds of the industrial water supply for the Eugene-Springfield service area is obtained

from McKenzie River. The remainder comes from wells. Those sources appear adequate through 2020. Existing water rights also appear adequate. Therefore, it appears that no new storage will be required for municipal and industrial purposes. However, full use of existing rights to natural flow would tend to deplete low-water flows and thus degrade fish-life habitat in the lower reaches of the McKenzie.

Projections of power needs in the basin and region indicate that any and all additional generating capacity which might be developed at a justifiable cost would be utilized.

Water pollution control needs are principally those for adequate treatment of waste loading as it develops. Present quality of flows is relatively good in the lower reaches and pollution is almost nonexistent upstream from the pulp mill near river mile 10.7. Present flows and minimum flows under State Water Resources Board programs are considerably in excess of those required to maintain satisfactory quality. Thus, subbasin needs do not warrant additional flow augmentation by storage. Downstream needs, however, are such that any increment of good quality flow would be of value.



Blue River Reservoir.



Cougar Reservoir.



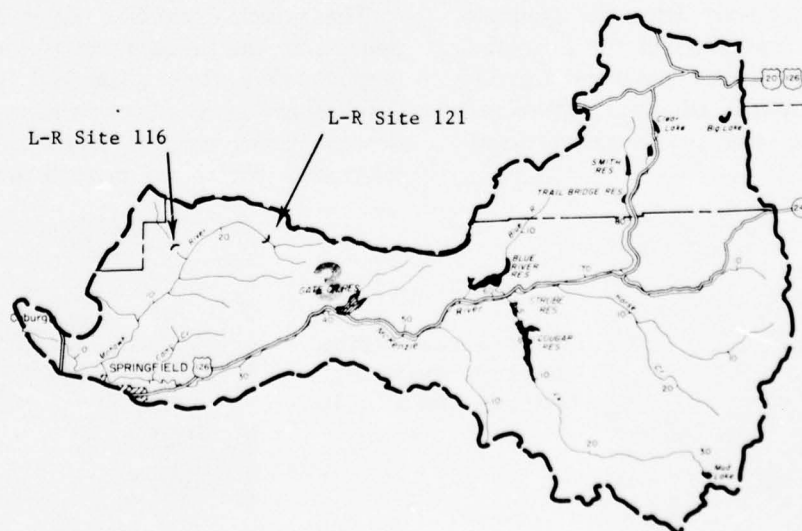
Beauty and water quality of McKenzie River to be preserved through environmental management.

The Plan

Functional needs of the subbasin for additional storage development are small, except for flood control. The degree of storage control in the subbasin, in terms of area from which runoff is controlled, is low. As the same time, the excellence of its recreational and overall natural environ-

ment is almost unparalleled in the basin as a whole. On the basis of all those considerations, development proposals are limited to programs and projects generally compatible with the concept of preservation of natural environment.

Early-Action Plan Elements. - No early-



action projects in McKenzie Subbasin are proposed. Main features of the early-action plan consist of: (1) channel modification to facilitate operation of the reservoirs for flood control; (2) private-sector irrigation development; (3) environmental management of McKenzie and South Fork McKenzie Rivers and White Branch, Horse, and French Pete Creeks, and all streams in the two wilderness areas; (4) local flood plain use regulation; (5) fish and wildlife programs with emphasis on angler and hunter access; (6) installation of two small group-enterprise jobs on agricultural land; and (7) soil and water restoration measures at 16 locations on O&C forest land and 38 locations in National forests. One watershed project which would divert water from McKenzie River near river mile 7, would be located primarily in Subbasin 5, and is included in the discussion for that subbasin.

Long-Range Features. - No major development is planned for the long-range period. Two small reservoirs (aggregate capacity, 37,200 acre-feet) in the upper reaches of Mohawk River are included primarily to serve the functions of flood control and irrigation. Other features of the plan include: (1) additional channel modification on McKenzie River to facilitate flood control operation of the reservoirs, (2) 16 miles of flood control and drainage work on the minor tributaries, (3) recreation facilities, and (4) irrigation distribution facilities.



Diverse recreation - boating, swimming, hunting and fishing.



Long Tom Subbasin

The Setting

The Long Tom area, a Coast Range drainage, includes metropolitan Eugene and a number of smaller communities. The upper portions of the drainage are low mountains; the lower portions are nearly flat with meandering streams.

The economy is based upon agriculture, food processing, forest products harvest and manufacturing, and the various industrial and service functions associated with a sizable urban development. Population in the subbasin was 108,000 in 1960, mostly concentrated in the Eugene area. Population is projected to more than triple by 2020. It is expected that the present urban and suburban buildup will continue and the future will see the entire eastern portion of the subbasin in various stages of urbanization.

The principal existing water resource projects in the subbasin are the multiple-purpose Fern Ridge Dam and Reservoir (including Long Tom channel), the Amazon Creek channel, and several bank revetments. Watershed projects which are





Fern Ridge Reservoir.

either constructed or under construction include the Amazon-Flat Creek, Spencer Creek, Central District, Hulbert Lake, and River Road projects, and a part of the Willakenzie Project.

Fern Ridge Dam and Reservoir is authorized to be operated for flood control, irrigation, and navigation. Irrigation demands have been small, but are growing rapidly. Recreation use is heavy and rapidly growing.

Anadromous fish are stocked in the system by Fish Commission of Oregon. Native cutthroat trout have adapted themselves to survive in some stream reaches despite unfavorable summer water conditions. Projected needs for trout fishing can be met by habitat improvements such as sill logs in streams, construction of fishing impoundments, improved angler access, and artificial propagation. Warm-water game fish are plentiful in Fern Ridge Reservoir, Long Tom River downstream, and several oxbow lakes along Willamette River. Improved fisherman access constitutes the only action required to meet projected needs for warm-water game fishing.

Specific wildlife needs are related to waterfowl and bandtailed pigeons. Increased waterfowl habitat would result from the stabilization of water levels at Fern Ridge, and water management on adjoining lands.

Fern Ridge Reservoir, including the Long Tom channel improvements, provides a high degree of protection against major floods in Long Tom River. Uncontrolled runoff from tributaries downstream from Fern Ridge, however, still causes damage in the subbasin and contributes to damages downstream along Willamette River. Also, Willamette River floods cause damages along the northeastern edge of the subbasin and increase stages in lower Long Tom River. Evacuation of stored floodwaters causes problems of extended inundation of some low-lying areas; the existing channels of the Willamette and lower Long Tom are not adequate to contain evacuation releases plus natural flows during the evacuation period following a major flood.

Long Tom Subbasin contains about 132,000 acres of irrigated and potentially irrigable land. Overall, the irrigation water supply in the subbasin is inadequate to



Confluence of Long Tom and Willamette Rivers - 1964 flood.

meet future needs unless additional storage is developed or an additional supply is imported. That shortage is compounded by the rapidly growing demand for retention of stored water in Fern Ridge for recreation and related uses. However, additional supplies are available in Willamette River from natural flows; those flows and water stored in upstream Federal reservoirs can be diverted to serve irrigation needs in a portion of the area.

Municipal and industrial water needs for most of the Eugene-Springfield service area and several other communities are supplied from sources outside the subbasin. Monroe's projected needs as of 2020 exceed its surface-water right by about 1.7 mgd. Consequently, it appears that new storage or ground-water development will be needed to meet Monroe's long-range needs.

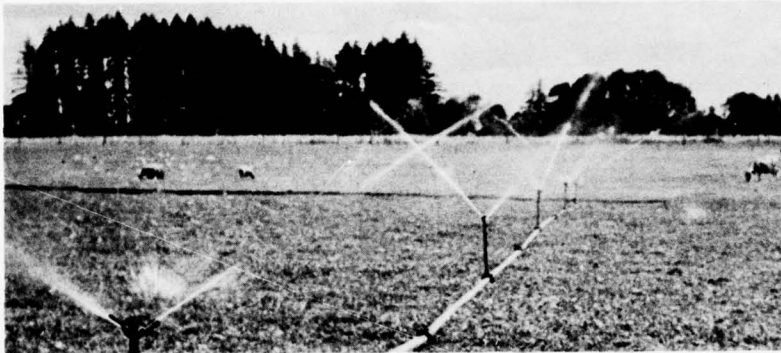
Present slackwater resources are ade-

quate to meet projected recreation needs, provided that Fern Ridge Reservoir can be maintained at full or near-full levels during the recreation season. However, additional recreational facilities will be required as deficiencies already exist.

Fern Ridge Reservoir inflow is minor during the summer months and the large, shallow reservoir has prolific algal production. Natural turbidity, high temperatures, and noticeable algal blooms lessen the attractiveness of Long Tom River downstream from the dam. The waste load on the stream is minor and the flows required to assimilate that load are considerably less than flows required for other purposes.

The Plan

In addition to the need to resolve the problem of irrigation, navigation and flood control needs versus recreation demands on



With irrigation,
dry cropland
becomes dairy
pasture.

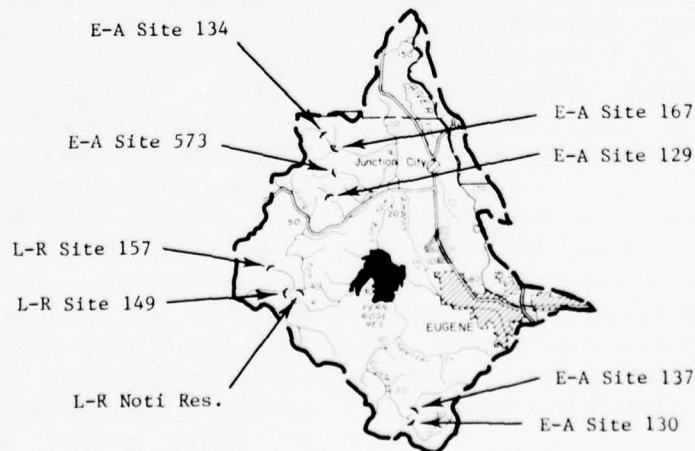
Fern Ridge Reservoir, there are substantial identified needs in the subbasin for additional multiple-purpose storage development. Principal functional needs which require active response are: (1) flood damage reduction, (2) irrigation water supplies and facilities, (3) additional recreational facilities, (4) improved wildlife habitat, and (5) watershed protection measures. The plan for Long Tom Subbasin is presented following.

Early-Action Plan Elements. - Early-action features include service for both subbasin needs and downstream purposes. Principal elements are three small watershed projects and Fern Ridge Project modification.

Small watershed projects are those for the Coyote-Spencer, Bear Creek, and Ferguson Creek watersheds. Those projects

would be developed to satisfy local desires for flood protection, irrigation, recreation, and fish and wildlife. The three projects include six multiple-purpose reservoirs with an aggregate capacity of 42,900 acre-feet. Of this storage, 2,200 acre-feet are not assigned to any specific use, and further studies will be required to either identify needs or modify reservoir capacities. In addition to storage and related facilities, the watershed projects would include provisions to meet associated land treatment needs, about 12 miles of channel improvement, and an irrigation distribution system. Channel improvement activities would be closely coordinated with fish and wildlife agencies.

Fern Ridge Project modification, for recreation, would entail provisions of additional, or replacement, water supply. The



total need, if all present and future problems were to be resolved, would be for about 120,000 acre-feet. The available upstream sites in the early-action plan could provide no more than about one-tenth of that total. The Noti site, in the long-range plan, could provide no more than one-fourth. Diversion from Willamette River, possibly by local effort and using either or both natural flows and stored water from upstream sites on the stream system, would be a logical first step to resolve the problem. Such diversion apparently could provide all of the justifiable replacement supply needed to supplement additional storage in the Long Tom system upstream from Fern Ridge.

Other elements of the early-action plan include: (1) channel modification to facilitate flood control operation of existing reservoirs, (2) private-sector irrigation development, (3) additional acquisition of lands and development of recreation facilities at Fern Ridge Reservoir, (4) watershed management improvement programs, (5) flood plain use regulation, (6) fish and wildlife programs, (7) installation of eight small group-enterprise jobs on agricultural lands, and (8) soil and water restoration measures at six locations on O&C forest lands.

Long-Range Features. - Three additional reservoirs are included in the long-range plan. They are Noti Reservoir on upper Long Tom River with a capacity of 35,000 acre-feet, Poodle Creek Reservoir on Poodle Creek with 14,300 acre-feet, and Log Pond Reservoir on Elk Creek with 20,000 acre-feet. Those reservoirs could help provide replacement storage for Fern Ridge.

Other features of the long-range plan include: (1) additional channel modification to facilitate flood control operation of reservoirs, (2) private irrigation development, (3) a large-scale irrigation project, (4) 28 miles of channel work on minor tributaries, and (5) additional recreation facilities.



Santiam Subbasin

The Setting

The Santiam region typifies the range and variety which is Willamette Basin. Driving east from Albany, the motorist leaves the urban and passes the suburban, the rural agricultural, the rolling grassland foothills, the dense evergreen forest, the alpine meadows, and finally the Cascade peak areas. The 2,440 square miles are 72 percent forested and 24 percent agricultural. Population was 65,200 in 1960. The region's economy is consistent with the land use in that it is heavily dependent on timber harvest and processing, agriculture, and tourism.

Existing Federal reservoirs include Detroit and Big Cliff on North Santiam River, Green Peter on the Middle Santiam, and Foster on South Santiam River. Authorized purposes are flood control, navigation, irrigation, and power generation. In addition, Holley Reservoir on Calapooia River and Cascadia Reservoir on South Santiam River have been authorized for flood control, navigation, and irrigation.

With existing and authorized reservoirs, minimum fish flow could be met through 2020 on Santiam and on North and South Santiam Rivers. Barriers to fish passage exist at Detroit Dam on North Santiam River and at eight other locations in the subbasin. Fisherman-access programs are needed to permit utilization of natural production of warm-water game fish. The principal needs for the cold-water fishery are increased hatchery production, stocking of existing streams and lakes, and



Detroit Reservoir.



Big Cliff Reservoir.



Foster Reservoir.



Green Peter Reservoir.

fisherman-access programs. Hunting opportunities are insufficient to meet current demands and are likely to remain so in the future.

Annual flooding occurs on about 50,500 acres in the subbasin. Resulting average annual damages of more than \$1 million are projected to almost double by 2020 if no additional measures are taken. The three existing and two authorized reservoirs will provide substantial flood control, but will not be adequate to fully meet the identified needs. Channel stabilization facilities are needed for about 23 miles on major streams in the subbasin, and channel improvements for flood control and drainage are needed on about 145 miles of small tributaries.

Irrigation is expected to increase from the present 54,800 acres to about 232,000 by 2020. The water requirements for such

expansion will be in the order of four times the present diversions. A portion of the storage in the existing Detroit and Green Peter Reservoirs and in the authorized



1964 Flood - South Santiam River near Lebanon.

Holley and Cascadia Reservoirs is available for irrigation use. With the exception of a few isolated areas, storage in the existing and authorized reservoirs would be adequate to meet the water demands to 2020. In addition, numerous farm-pond sites are available and ground water supplies are abundant along the larger streams.

Natural flows and ground water provide the source of municipal and industrial water for the towns and communities. It appears that future demands can be met without developing storage for that specific use. The City of Salem, located outside the subbasin, obtains its water supply from North Santiam River.

There is, and will continue to be, a surplus of water-surface area in the subbasin for recreation use. However, the available recreation facilities meet less than 85 percent of the present demands, and would satisfy less than 20 percent of the 2020 needs. There is a need for special attention to: (1) development of new recreation areas, (2) encouragement of private-sector recreational development, (3) improved public access along Willamette River and lower Santiam and Calapooia Rivers, and (4) development of high-potential recreation sites in the forested Cascade Range.

Water quality in North Santiam River is excellent and is expected to remain so even though a rather large waste load is projected for the future. Increased flows from Green Peter and Foster Reservoirs, together with newly constructed waste treatment plants on South Santiam River, have greatly reduced pollution problems on that stream. Water quality problems on Calapooia River also are expected to be resolved with construction and operation of Holley Reservoir. Therefore, additional storage specifically for water quality purposes is not needed in the subbasin.

The Plan

There is an ample need for further development in the subbasin. The plan elements, selected on the basis of physical and economic feasibility, functional compatibility, and timing of implementation, are presented following.

Early-Action Plan Elements.— Early-action features include modification of the plan for the authorized Holley Dam, four small watershed projects, two multiple-purpose reservoirs, one small irrigation project, and other miscellaneous items.

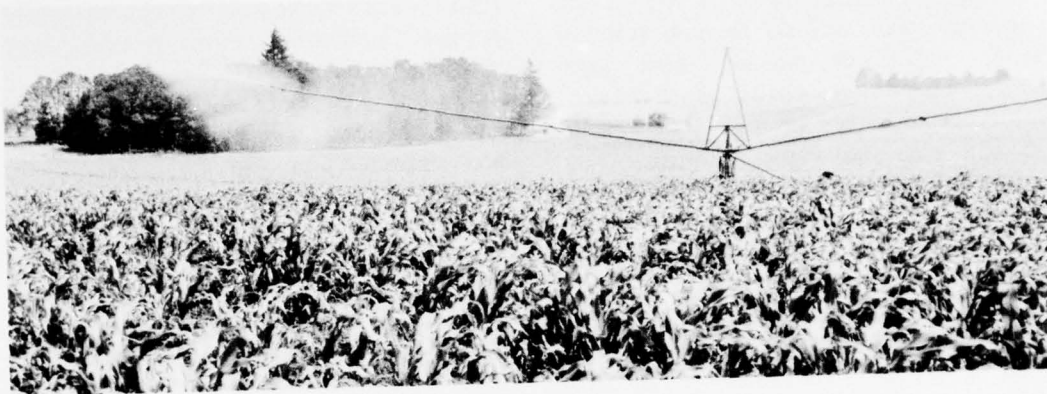
The authorized 97,000-acre-foot Holley Dam on Calapooia River would be recommended for reauthorization at 145,000 acre-feet. The increased capacity would be utilized to serve additional needs for recreation, fish and wildlife enhancement, M&I water supply, and water quality control.

Small watershed projects include San Thomas, Walton Slough, Grand Prairie, and East Muddy Creek. Structural measures do not include any reservoirs but consist of about 58 miles of channel works and irrigation distribution systems for 10,200 acres.

The two multiple-purpose reservoirs are Jordan on Thomas Creek and Lyons on Little North Santiam River. Both would serve the functions of flood control, water quality, navigation, fish and wildlife, recreation, and municipal water supply; additionally, Jordan would provide irrigation water supplies. Jordan Reservoir would have a capacity of 93,000 acre-feet and Lyons Reservoir 110,000 acre-feet.

A single-purpose irrigation project in the Brownsville area would incorporate two pumping plants and a pressure-pipe distribution system to irrigate 8,700 acres. This project would use water stored in the proposed Holley Reservoir.

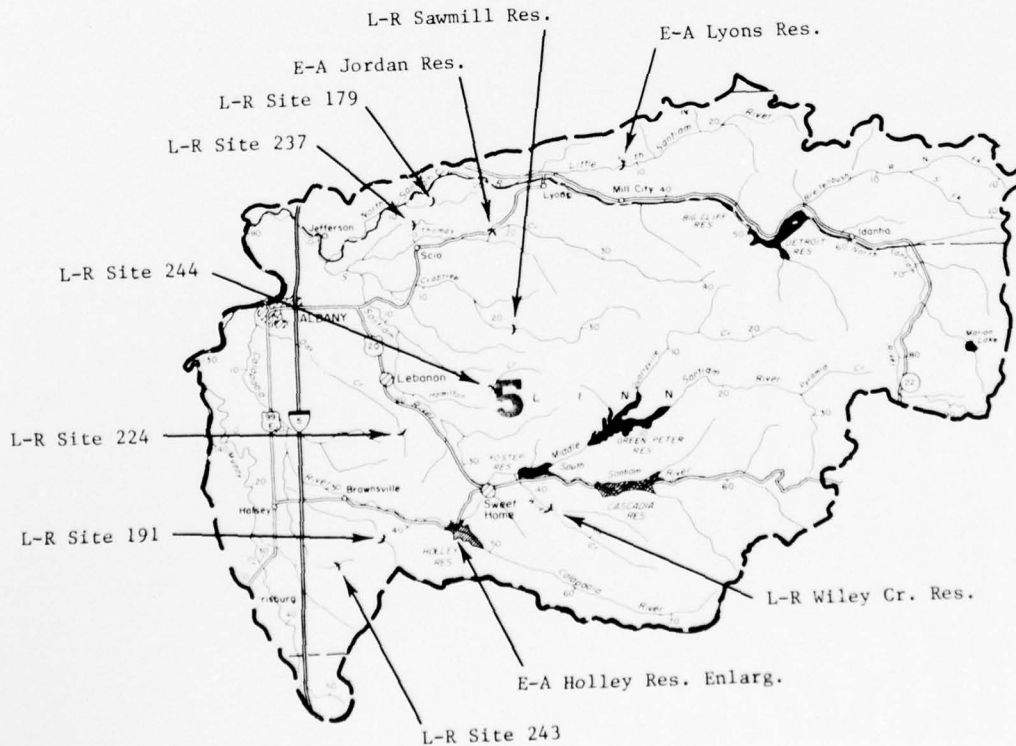
Other features of the early-action plan



Irrigation makes possible several crops annually.

include: (1) channel modification to permit efficient flood control operation of reservoirs, (2) recreation facilities, (3) private irrigation development, (4) acquisition of four mineral springs, (5) local programs of flood plain use regulation, (6) installation

of 11 small group-enterprise jobs on agricultural lands, (7) soil and water restoration measures at 28 locations on O&C lands and at 29 locations in National forests, and (8) environmental management of selected streams.



Long-Range Features.—Features in the long-range plan include six reservoirs in small watershed projects; two large multiple-purpose reservoirs; expanded irrigation development; pumped-storage facilities; and other miscellaneous items.

Small watershed projects would be located on Bear Branch, Sucker Slough, Courtney Creek, Little Muddy Creek, Oak Creek, and Hamilton Creek. The six associated reservoirs would have an aggregate capacity of 53,000 acre-feet and be operated primarily for flood control. Also included in these projects is 86 miles of channel work.

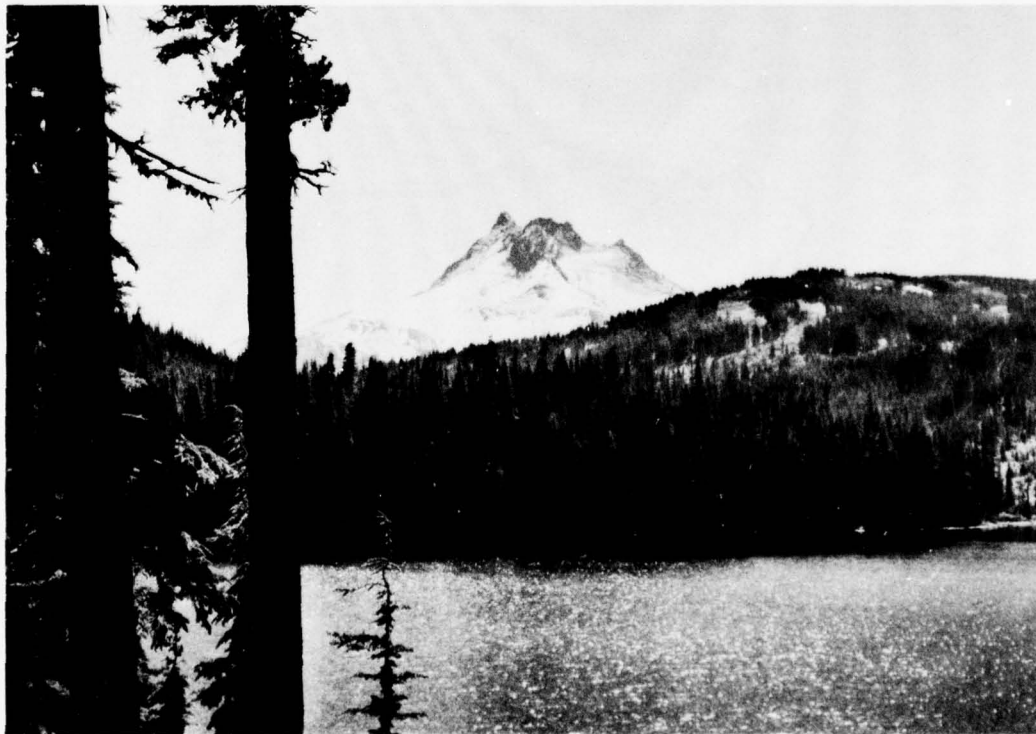
The two major reservoirs included in the plan are Sawmill on Crabtree Creek and Wiley Creek on the stream of the same name. Sawmill Reservoir would have a capacity of 70,000 acre-feet and Wiley Creek about 65,000 acre-feet. These two

reservoirs are included in the plan primarily to meet flood control needs; however, they would serve other functions also.

Irrigation development would be extensive in the long-range phase. Large projects are expected in the Calapooia, Scio, Coburg, and Grand Prairie areas. Water supplies are available in the existing and authorized Federal reservoirs.

Two pumped-storage facilities would provide 5 million kilowatts of peaking capacity. Snow Peak would be associated with the proposed Sawmill Reservoir. Little Meadows would involve reservoirs at Little Meadows and on Quartzville Creek.

Other features included are: (1) additional channel modifications to facilitate evacuation of flood control space in reservoirs, (2) private irrigation development, and (3) recreation facilities.



Breitenbush Lake near the base of Mt. Jefferson.



Coast Range Subbasin

The Setting

The several tributary streams which enter the Willamette from the west, namely Marys River, Luckiamute River, Rickreall Creek, and Yamhill River, drain an area designated Coast Range Subbasin. This is basically a forest and agricultural area with widely separated population centers at Corvallis, McMinnville, and West Salem.

Total population in the subbasin in 1960 was 96,950. Projections indicate that Coast Range Subbasin population will increase to more than 250,000 by 2020. The economy of the area is dependent on harvest and processing of forest products and on agriculture. The forest industry is expected to stabilize at about the present level of production. The lowlands along Willamette River and in the interior valleys amount to more than 25 percent of Willamette Basin's irrigable lands. Thus, agriculture is expected to continue as a mainstay of the subbasin economy.

Water resource development has been slow in the subbasin. There are no existing or authorized major reservoirs, and less than 100 total acres of water surface on small private and municipal reservoirs. No significant amount of unappropriated natural flow remains in the streams of the subbasin during low-flow season. Further, a major part of the subbasin is poorly supplied with ground water. However, there are potentially highly productive aquifers along Willamette River and in a few other scattered areas. Water, both natural flows and storage releases, is available in Willa-

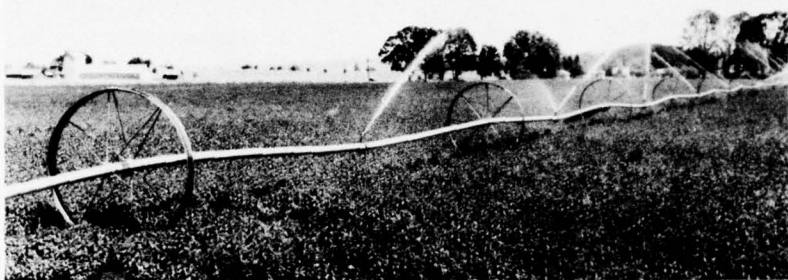
mette River for diversion into the subbasin.

Warm, low flows in the summer and fall severely limit the fishery resource, although the upper ends of the streams provide excellent rearing area for salmon and steelhead. Stream temperatures commonly exceed 70°F. and occasionally rise to 80°F. Barriers to fish passage include five small dams and five natural falls. To meet projected demands for resident fishery would require new impoundments, and fish production and fisherman-access programs.

Supplies of most wildlife species are insufficient to meet current demands. Specific wildlife needs include acquisition and development of several mineral springs for enhancement of pigeon habitat and hunting. Needs associated with the W. L. Finley and Baskett Slough Wildlife Refuges are for additional water supplies, habitat improvement, and public-use facilities.

Annual flooding occurs on about 52,000 acres in the subbasin. Some channel improvement and stabilization work has been done. Reduction of flood damages will require storage at several locations and about 135 miles of channel improvements and stabilization works.

Less than 10 percent of the nearly 450,000 irrigable acres in the subbasin is irrigated, and a tremendous opportunity for irrigation development exists. It is expected that more than 300,000 acres will be irrigated by 2020. Unappropriated natural flow during the irrigation season is practically nonexistent in the subbasin streams; however, there is a considerable amount of water available for diversion to the subbasin from existing upstream reservoirs in the Willamette system. Also, the potential ground-water-producing areas are expected to sustain several times the present use. A considerable portion of the lands, however, are not within economic serving distance of the ground-water areas



Less than 10% of the potential irrigable acres in the subbasin are irrigated.

or Willamette River. Irrigation of those lands will require new storage within the subbasin.

Municipal and industrial water supplies, although presently adequate in most cases, will need expansion to meet projected population growth, especially for the larger municipalities, such as Corvallis. It appears that Corvallis will have to increase its water rights and diversion from Willamette River, or obtain supplies from new storage development. Other municipalities which will require additional storage include Sheridan and Monmouth, and a few smaller communities may desire to participate in Federal or Federally-assisted projects.

Difficult access has limited the use of much of the natural recreation features, such as the timbered mountains and Willamette River. Present recreation facility capacity in the subbasin would satisfy only about 30 percent of the 1980 needs and about 15 percent of the 2020 needs. There is little water surface, except for Willamette River, available for public use within the subbasin. Multiple-purpose storage reservoirs with appropriate recreation facilities, extensive recreation development along Willamette River and subbasin streams, and public access programs will be needed to meet future demands.

Little water surface is available for public use except for Willamette River.



Minimum streamflows for water quality purposes have been identified for Marys, South Yamhill, and Yamhill Rivers. The requirements are not exceptionally high, and are met by natural flows.

The Plan

Because the ground-water resource is small, except in alluvium along Willamette River and portions of Luckiamute and Yamhill Rivers, it appears that use of existing upstream storage and development of new storage in the subbasin hold the greatest potential to best satisfy present and projected needs. Because of the general absence of Federal lands and major Federal reservoirs, there is both a need and the opportunity for non-Federal and private-sector development, particularly in the fields of recreation, irrigation, and M&I supplies. Also, there are opportunities for development of waterfowl and upland-

game management and shooting areas as a source of farm income. At the same time, there are needs and opportunities for development of Federal and Federally-assisted projects. This subbasin appears to have the most prospect for change in character during the next 50 years of any in Willamette Basin.

Early-Action Plan Elements.—Early-action features include nine small watershed projects, five multiple-purpose storage developments, two single-purpose irrigation projects, channel modifications, an environmental management program, and fish and wildlife habitat improvements.

The small watershed projects include West Muddy Creek in the Marys River area, Little Luckiamute River and Soap Creek in the Luckiamute area, Ash Creek in the Rickreall Creek area, and Chehalem Creek, Salt Creek, Palmer Creek, Spring Valley and Deer Creek in the Yamhill area. These projects would include 16 reservoirs with

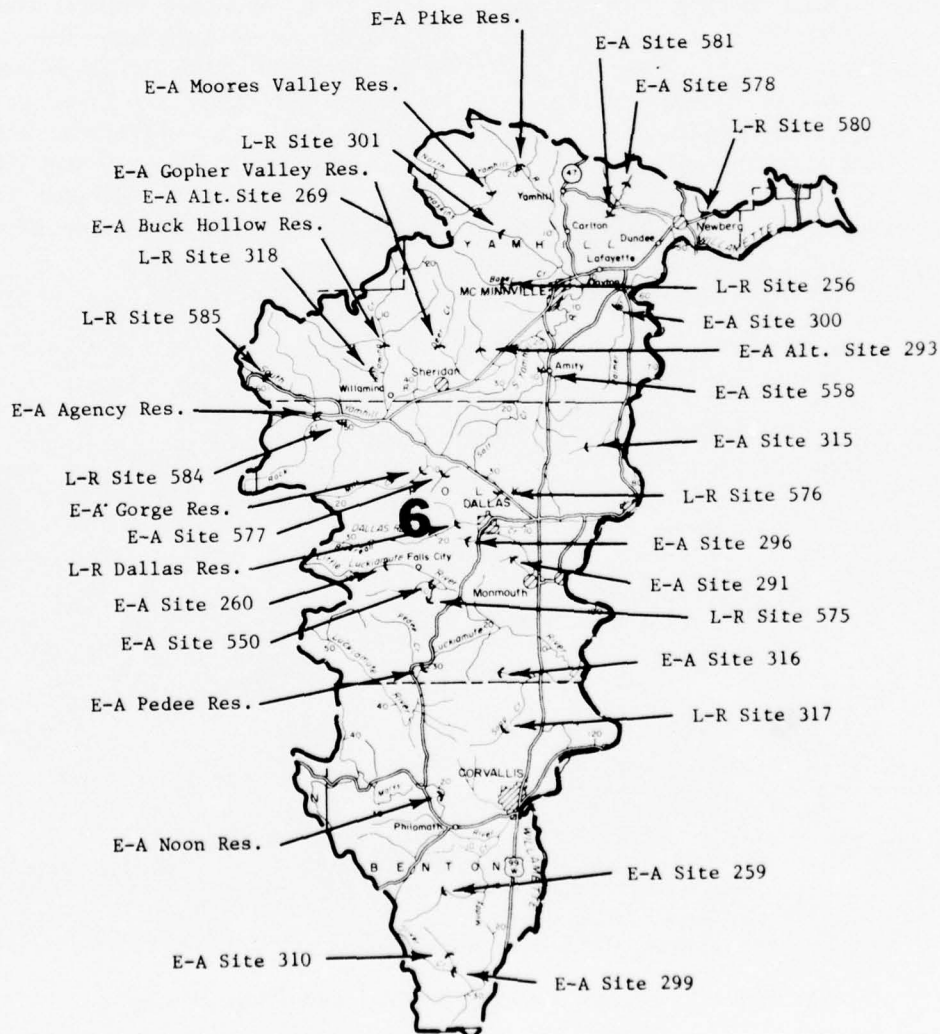


North Yamhill valley looking toward the Chehalem Mtns.

an aggregate capacity of 148,250 acre-feet. The Deer Creek project is an alternative to the Gopher Valley reservoir in the South Yamhill project discussed below. Other structural features include 73.5 miles of channel modification for flood control and drainage, irrigation distribution systems to serve a total of 27,100 acres, recreation facilities, and associated land-treatment measures. These watershed plans provide 14,200 acre-feet of storage for which no specific use has been identified; further studies will be required to identify needs or to modify reservoir sizes. The figures cited above include the Deer Creek project alternative.

Reservoirs in the Spring Valley and Palmer Creek Projects would provide irrigation service alternative to use of existing and authorized upstream Federal storage. If that source were used, the single-purpose Spring Valley reservoir probably could not be justified, and the multiple-purpose Palmer Creek reservoir would require reevaluation. Ground water is also an alternative source of supply in these areas, requiring further evaluation in detailed planning.

Two of the major reservoir projects included in the early-action plan are Noon on Marys River and Pedee on Luckiamute River. They are needed primarily for flood



control and to provide water surface for recreation, but would also store water for irrigation, fish and wildlife, and municipal and industrial purposes. Noon and Pedee reservoirs would have capacities of 115,000 and 130,000 acre-feet, respectively.

Six major storage developments would be located in the Yamhill area in association with the multiple-purpose Red Prairie, Carlton, and South Yamhill Projects. Red Prairie Project, serving the functions of irrigation (15,500 acres), flood control, recreation, and fish and wildlife, would utilize storage in Gorge Reservoir on Mill Creek, with a capacity of 53,000 acre-feet. Also included in the plan are provisions to deliver water to the Baskett Slough Wildlife Refuge for wildlife habitat improvement. Carlton Project, serving the functions of irrigation (30,000 acres), flood control, recreation, fish and wildlife, and possibly municipal and industrial water supply, would contain two reservoirs—Pike on North Yamhill River and Moores Valley on Haskins Creek, with capacities of 75,000

and 30,000 acre-feet, respectively. South Yamhill Project, to serve the functions of irrigation (50,000 acres), flood control, recreation, and fish and wildlife, would contain three reservoirs—Agency on South Yamhill River (78,000 acre-feet), Buck Hollow on Willamina Creek (84,000 acre-feet), and Gopher Valley on Deer Creek (33,000 acre-feet). The latter site is an alternative to the Deer Creek small watershed project reservoirs discussed above.

Two single-purpose irrigation projects are the Monmouth-Dallas and a private development on Palmer Creek, both of which would utilize natural flows of Willamette River. The Monmouth-Dallas Project would irrigate 28,000 acres in the Rickreall Creek area, and the development on Palmer Creek would irrigate about 3,500 acres. Construction of facilities has been completed on the latter project.

Other elements of the early-action plan include: (1) channel modification to facilitate flood control operation of reservoirs,



Artist's conception of Gorge Reservoir - The project would serve irrigation, flood control, fish and wildlife and recreation.

(2) development of additional wildlife habitat and public-use facilities at the two wildlife refuges, (3) acquisition and development of seven mineral springs, (4) private-sector irrigation development, (5) additional recreation facilities, (6) a local program of flood plain use regulation, (7) installation of 52 small group-enterprise jobs on agricultural land, (8) soil and water restoration measures at seven locations on O&C forest lands and seven locations in National forests, and (9) environmental management of portions of Marys River, Rickreall Creek, and Yamhill River.

Long-Range Features.—Elements of the early-action plan would satisfy a large block of water resource needs in the subbasin. However, additional demands for flood control, recreation facilities, and irrigation will require further resource development during the long-range period. Principal elements include a reservoir on Rickreall Creek and nine small reservoirs in the Luckiamute and Yamhill areas.

Dallas Reservoir, located on Rickreall Creek about 2 miles above the City of Dallas, would have a capacity of about 30,000 acre-feet. It would be required primarily for flood control, but would provide benefits to recreation, fish and wildlife, and possibly M&I water supply.

Two small reservoirs in the Luckiamute drainage, Sulphur Spring and Grant Creek, would be required primarily for irrigation purposes. They would have an aggregate capacity of 18,500 acre-feet.

Seven small reservoirs are proposed in the Yamhill area. They would be located on Salt Creek, Spring Brook, Rowell Creek, Panther Creek, Baker Creek, Tindle Creek, and Ead Creek. Aggregate capacity of the seven reservoirs would be 90,440 acre-feet and operation would be for flood control and other as-yet-undetermined purposes.

Other features of the long-range plan include: (1) additional channel modification to facilitate operation of the reser-

voirs for flood control, (2) additional Federal, Federally-assisted, and private irrigation development, (3) a continuing program of recreation facility construction, and (4) about 53 miles of tributary channel work.



Pudding Subbasin

The Setting

The principal streams of Pudding Subbasin are Molalla and Pudding Rivers, which head in the lower hills of the Cascade Range. The area contains a number of cities and towns (including Salem, the State capital) interspersed among agricultural and forest lands. About 46 percent of the subbasin is forest land, and about the same is in agricultural use. Forest products harvesting and processing, agriculture, food processing, tourism, and government services are all important aspects of the economy. Population of the area was 127,800 in 1960, a density of about 108 persons per square mile.

Projections indicate a 2020 population of nearly 335,000. Most of the population increase is likely to take place in and around existing cities and towns; however, it seems reasonable to expect that an area such as this, which is reportedly first in the Nation in canning and freezing of fruits and vegetables, will retain its agricultural emphasis.

The most pressing functional needs are those associated with fish and wildlife enhancement, flood control, irrigation,



Oregon State Capitol at Salem.

water quality and recreation. There are no existing, authorized, or assured major multiple-purpose projects in the subbasin, and no Federal recreation development on Federal lands.

Molalla River flows are only reasonably well sustained during the summer months, and the flows of Pudding River and tributaries become very low during that period. Water temperatures exceed acceptable levels for cold-water fish in Pudding River, the lower reaches of Molalla River, and the low-elevation tributaries. To meet the projected demands for resident fishery would require new impoundments and fish production programs. Supplies of many wildlife species are insufficient to meet present demands; for many species, that condition will continue in the future. Wildlife development needs include acquisition of a pigeon spring and improvements to Ankeny Wildlife Refuge.

Annual flooding occurs on about 28,300 acres in the subbasin. Damages now amount to about \$537,000 annually, and

studies indicate that flood plain management would not provide the answer to the problem. Storage sites are available in the Molalla River drainage to effectively control floods at Canby. However, storage possibilities in the Pudding River drainage lack the physical capability to effectively control the river; there would remain a



1964 Flood - Molalla River at Goods Bridge.

Youth group recreational facilities at Silver Falls State Park.



need for channel improvement measures and the subbasin would still contribute to downstream flood flows.

Irrigation development is limited because there is no appreciable unappropriated natural flow in the subbasin streams. However, there is a considerable amount of water available in North Santiam and Willamette Rivers from existing and authorized Federal reservoirs. In addition, the ground water potential, particularly in the French Prairie area, is expected to sustain several times the present level of use. Some of the irrigable lands, however, are situated away from the ground water areas and existing supplies of stored water. Those lands would require new storage development at several places within the subbasin.

Effective land treatment measures are in use throughout the subbasin. However, maintenance of high soil productivity and minimum erosion losses, and improvement of water quality downstream, would require continued efforts and investments in conservation measures and watershed protection.

Recreation facility capacity in the subbasin would satisfy only about one-fourth of the projected subbasin demands in recreation days. Water-surface capacity for recreational use also fails, by a considerable

amount, to meet projected demands. Multiple-purpose storage reservoirs, with accompanying facilities, and extensive recreation developments along Willamette River and other streams could satisfy subbasin needs as projected to 2020. The Recreation Committee recommends that Molalla River, Butte Creek, and Abiqua Creek be retained in natural condition under an environmental management program.

Present M&I needs are served from surface and ground water sources, which appear adequate to meet future demands. The City of Salem, which obtains its water supplies from North Santiam River, is considering a contract for use of water stored in Detroit Reservoir, in adjacent Subbasin 5, to augment its water supplies in the future.

The major water quality problem occurs in Pudding River. Extremely low flows and velocities result in high temperatures and generally poor quality each summer. Flow augmentation is needed.

The Plan

Neither a reasonable degree of flood control nor of service to irrigation, fish and wildlife, recreation, and water quality needs in the subbasin could be provided

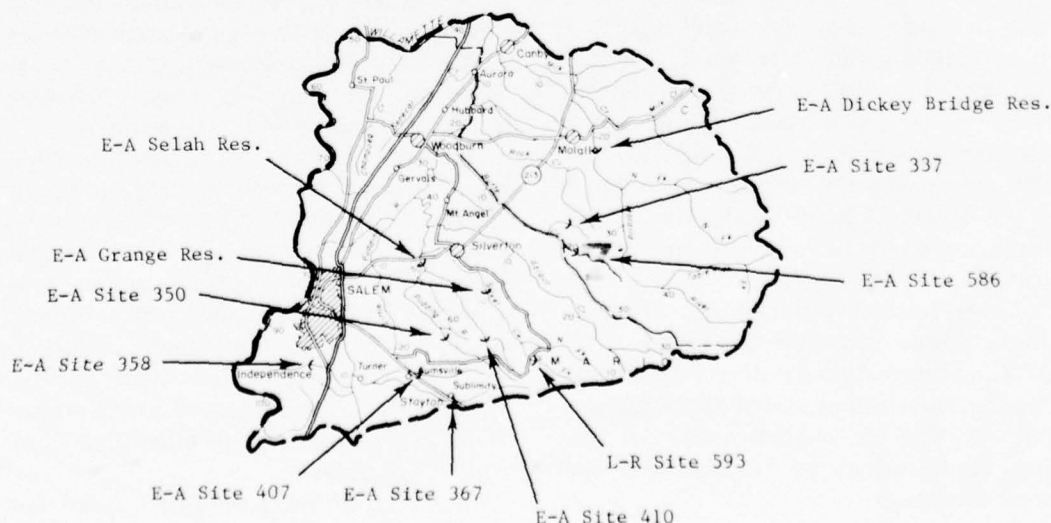
without storage. Thus, multiple-purpose storage projects would be the core of subbasin development. Such projects also could contribute to meeting needs outside the subbasin, both for flood control and for flow augmentation.

Three of the five principal subbasin streams are recommended for environmental protection and management. Storage reservoirs on the remaining two streams—Pudding River and Silver Creek—cannot physically provide the needed water supplies. Therefore, storage will be required on at least one of those streams recommended for environmental management.

Early-Action Plan Elements.—The early-action features include: (1) three small watershed projects, (2) a large multiple-purpose storage development, (3) modification of an authorized channel project for flood control, (4) a system of channel modifications associated with flood control storage, (5) wildlife improvements, (6) an environmental management program, and (7) extensive recreation development. Also, considerable individual and group irrigation development, based on use of ground water, is anticipated in this area.

Small watershed projects include Butte Creek, Drift Creek-Pudding River, and Mill Creek. These three projects include seven multiple-purpose reservoirs totaling 65,400 acre-feet. Channel work for flood control and drainage purposes totaling 21.5 miles in length would be made on Mill, Battle, Porter, and McKinney Creeks and on Turner Diversion. Other structural measures include irrigation distribution systems for 7,500 acres and numerous recreation facilities. These watershed projects provide 8,550 acre-feet of storage for which no specific use has been identified; further studies will be required to identify needs or to modify reservoir sizes.

The multiple-purpose Molalla Project would serve the functions of irrigation, flood control, recreation, and fish and wildlife. Principal project structures would be three reservoirs—Selah on Pudding River (capacity 22,000 acre-feet), Grange on Silver Creek (80,000 acre-feet), and Dickey Bridge on Molalla River (273,000 acre-feet). In addition, a canal would be provided to bring water from North Santiam River to irrigate lands in the project area, utilizing water supplies from storage at the



existing Detroit Reservoir on that stream. In total, the project would irrigate 100,000 acres, of which about 5,500 acres are in the adjacent Clackamas Subbasin.

Authorized channel work for Pudding River would be modified to include development of the recreation potential. Principal elements of the 46-mile project would be channel clearing and excavation on Pudding River and similar improvement on Pudding River tributaries. Close coordination of detailed planning with fish and wildlife and recreation agencies would be essential.

Other features of the early-action plan include: (1) channel modification to permit efficient flood control operation of the reservoirs, (2) recreation facilities, (3) private irrigation development, (4) acquisition of a mineral spring, (5) improvement for the Ankeny Wildlife Refuge, (6) local programs of flood plain use regulation, (7) installation of 21 small group-enterprise jobs on agricultural lands, (8) soil and water restoration measures at nine locations on O&C lands, and (9) environmental management of selected streams.

Long-Range Features.—These features include one small reservoir and other miscellaneous items. The South Fork Silver Creek storage project would impound about 25,000 acre-feet of water. It would provide storage space for flood control, stored water for recreational use, and a reservoir fishery. Before it could be constructed, an existing legislative withdrawal of the waters of South Fork Silver Creek would have to be amended to permit storage.

Other features included are: (1) additional private irrigation development; (2) additional recreation development, both on Pudding River and as part of the Willamette Parkway System; and (3) additional channel modifications on Molalla River and small tributaries.



Tualatin Subbasin

The Setting

Tualatin River drains a part of the eastern slope of the Coast Range adjacent to the Portland metropolitan area. The lower valley is a transition between rural areas and encroaching suburban and urban developments; the upper portions are forested foothills and low mountains. About 50 percent of the subbasin is forested and 37 percent is in agricultural uses.

The economy is based on forestry, agriculture, light industry, and services. Population was 114,000 in 1960, density about 160 people per square mile. It appears likely that the future will see a continued urbanization of the Tualatin area. Population projections show an expected 364,000 persons by 2020. This area has the combination of rural scenic features and a nearness to Portland that makes it attractive for light "footloose" industry, residential development, and recreation.

Tualatin Subbasin has a variety of functional needs. The most limiting factors in fishery production are low, warm stream-flows in the summer. Dissolved oxygen content far below acceptable standards is common in lower Tualatin River during low-flow periods. Increased pollution, coupled with deteriorated water quality, could destroy the resident trout and warm-water fishery and preclude establishment of runs of fall Chinook.

Supplies of most wildlife species are

insufficient to meet present demands and for some will continue so in the future. The outlook for meeting big game and waterfowl needs is extremely poor.

The low-water profile of Tualatin River has a near-zero slope for about 30 miles upstream from a private diversion dam near the mouth, and the channel is tortuous and constricted. Thus, there are substantial flood and drainage problems on much of the valley floor. Flooding occurs annually on about 15,500 acres in the subbasin. Without additional flood control measures, flood damages by 2020 are expected to increase by about 2-1/2 times. Flooding and drainage problems cannot be solved by storage development nor by channel work alone. However, a combination of storage on several of the major streams plus a major channel modification project would go a long way toward alleviation of these problems. Land measures and watershed projects are also needed, and would be compatible with major structural improvement.

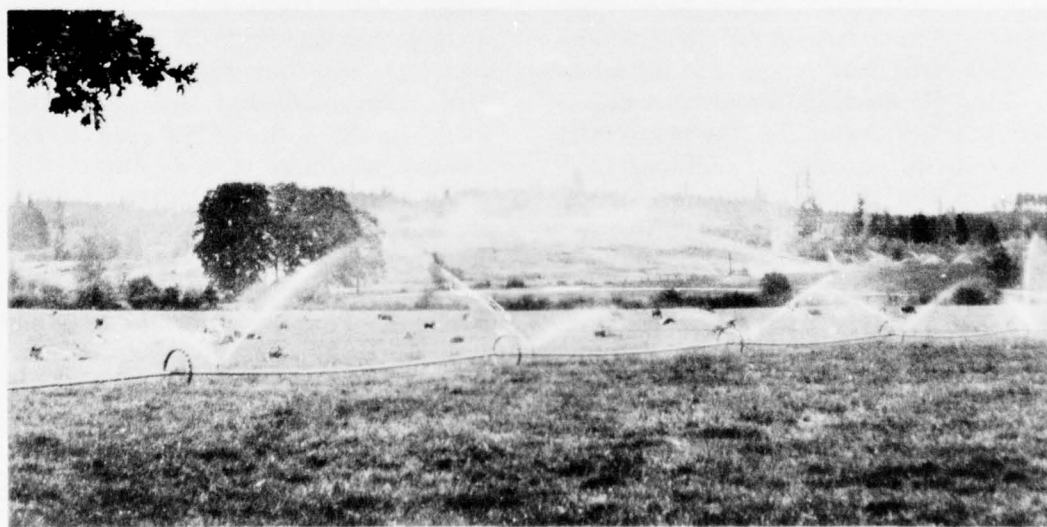
Irrigation land and water needs are expected to increase rapidly through 2000, then decline slowly as urban and industrial



1964 Flood - Tualatin River below Hillsboro.

expansion replaces agricultural use. To meet the water demands for some 55,000 additional acres expected to come under irrigation by 2000 will require about five times the water now diverted. Ground water supplies are limited in this subbasin and Willamette and Columbia Rivers are too distant to economically serve the lands. Some farm pond development is expected, but the most likely and abundant source of water for irrigation will be storage reservoirs within the subbasin.

Communities in Tualatin Subbasin have become very water conscious, having experienced shortages and having lost industries



Irrigated pasture in Tualatin Valley.

for lack of water. Authorized and assured Federal projects are presently planned to provide M&I water from storage. Scoggins Reservoir, on Scoggins Creek, will provide 14,000 acre-feet annually and McKay-Rock Creek Project reservoirs an additional 13,500 acre-feet. Hillsboro is developing an out-of-basin water source, in which Forest Grove may participate. The source is the North Fork of Trask River, on the coastal slope of the Coast Range. About 4,000 acre-feet of storage is being provided and there is a possibility for increasing to 20,000 acre-feet in the future.

Although available only in limited quantities in the subbasin, ground water is expected to continue to supply farm units and other rural dwellings requiring small quantities of water. In parts of the western end of the subbasin, however, ground water is inadequate even for rural needs.

The capacity of existing recreation facilities is extremely deficient in terms of meeting current as well as future needs. In addition, there is no water-surface area available for public use within the subbasin, except for some sections of Willamette and Tualatin Rivers. Three multiple-purpose Federal reservoirs—the authorized Scoggins and recommended McKay and Rock Creek—will make substantial contributions in both water surface area and recreation facilities. However, additional water surface area and facilities will be required to meet future needs. Provision of additional facilities on the streams, particularly along Tualatin River, would make a sizable step toward satisfying the recreation facilities requirements.

Water quality is poor in Tualatin River and most of its tributaries in the urbanized portion of the subbasin. Municipal and industrial wastes discharged from 20 treatment plants to Tualatin River and its tributaries receive more than 85 percent biochemical oxygen demand removal, and disinfection. However, even with that de-

gree of treatment, additional flows are required to meet dissolved oxygen requirements in Tualatin River.

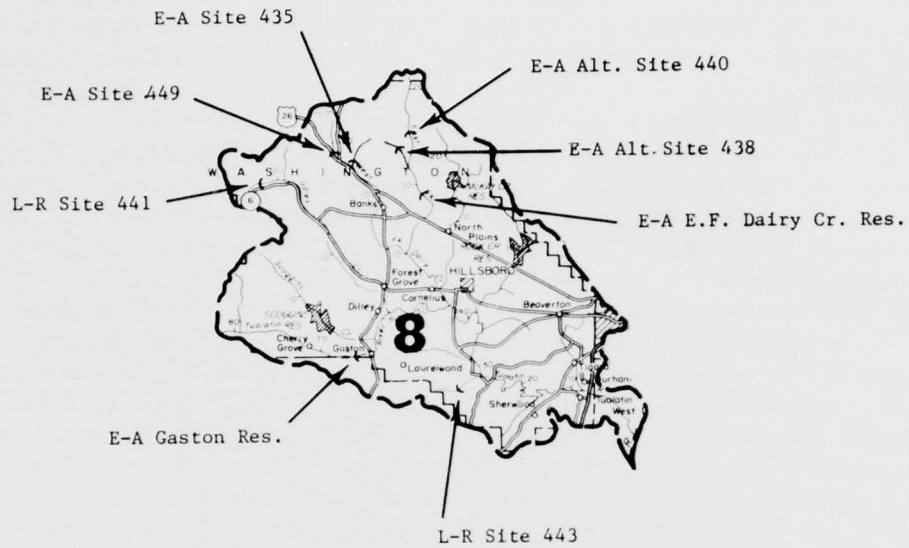
The Plan

Because of the high population density, proximity to the basin's major population center, and lack of water resource development, there is a substantial need for multiple-purpose water and land resource development. There are no major existing water resource developments in the subbasin. For formulation purposes, however, the authorized multiple-purpose Tualatin Project and the assured McKay-Rock Creek Watershed Project were considered as features of a base system.

Early-Action Plan Elements.—Proposals for early action include one large multiple-purpose project involving two reservoirs; two small watershed projects, one of which might be developed in lieu of one reservoir in the multiple-purpose project; one major multiple-purpose channel improvement project; and other miscellaneous features.

Tualatin Project, Second Phase, would serve the functions of irrigation, M&I water supply, water quality control, fish and wildlife, and recreation. In addition, some flood protection would be obtained incidental to operation for other purposes. Two reservoirs—Gaston and East Fork Dairy Creek, with 68,000 and 47,000 acre-feet of storage capacity, respectively—would provide an irrigation water supply for 30,000 acres, in addition to serving the other functions.

West Fork and East Fork Dairy Creek Watershed Projects would be multiple-purpose developments to satisfy a variety of local needs that could not be served by other elements in the plan. Principal features of the two projects are four reservoirs with a combined storage capacity of 32,200 acre-feet, 12 miles of channel improvement, an irrigation distribution sys-



Artist's conception of Scoggins Reservoir, Tualatin Project.

tem for 5,500 acres, recreation facilities, and appropriate land treatment measures. The two East Fork watershed project reservoirs are alternatives to the East Fork Dairy Creek reservoir discussed in the previous paragraph.

Tualatin River channel improvement would involve straightening and enlarging 63 miles of the present stream channel, deepening the lower end of the channel, and replacing the old Oregon Iron and Steel Company dam with a structure which could both maintain a summer pool and pass flood flows. Other features of the project include development or preservation of several oxbow lakes and adjacent lands for recreation and open space; provision of improved access to the river and recreation areas; general care during construction to maintain fish and wildlife habitat and esthetics; and planting and landscaping to repair any unavoidable damage occasioned by construction.

Other features of the early-action plan would include: (1) private-sector provision of irrigation facilities, (2) a local program

of flood plain use regulation to complement proposed flood control measures, (3) installation of 23 small group-enterprise jobs on agricultural lands, and (4) additional recreation facilities to complement and supplement the recreational opportunities of the subbasin.

Long-Range Features. —Beyond the early-action period, the principal needs will be for some additional multiple-purpose storage development, channel improvement, and recreation facilities.

Two small reservoir projects, one located on Gales Creek and one on McFee Creek, are included in the long-range plan. Both reservoirs, with combined storage capacity of 27,000 acre-feet, would be operated for flood control and for other, as-yet-undetermined purposes. Other plan features would be continuation of flood prevention and recreation programs implemented during the early-action period. Specific features include channel improvement and provision of additional recreation facilities.



Tualatin River joins the Willamette.



Clackamas Subbasin

The Setting

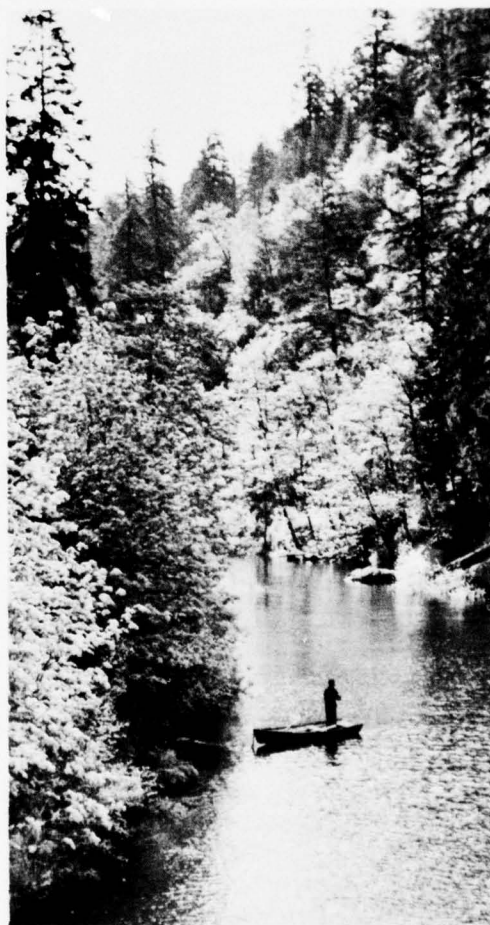
Clackamas Subbasin is a heavily forested, relatively rugged drainage, with a considerable network of access roads but a sparse population. The area is 85 percent forested and 12 percent used for agriculture. Population in 1960 was 35,700, for an average density of only 35 persons per square mile. The economy is strongly dependent on harvest and processing of forest products. The area is heavily used for scenic, hunting, fishing, and general recreational pursuits. Projections indicate that the subbasin will remain a sparsely populated area except in the portion adjoining the Portland metropolitan area. As Portland population increases, there will be an ever-increasing recreation demand, particularly for day-use. It seems likely that Clackamas Subbasin will become one of the environmental release valves for social pressures generated in the expanding urban area.

Although there has been no Federal storage constructed in the subbasin, there has been considerable private development of hydroelectric power projects. Recreation potentials are large but, because of the proximity of Portland, demand for water-related activities exceeds water-surface and facility supply. A particular need exists for development of day-use and group-camp facilities, especially for youth-oriented activity, close to Portland; for sightseeing loop roads; and for preservation of roadside and streamside beauty.

Substantially all of the streams of the subbasin are used by resident and anadromous cold-water fish; resident warm-

water fish are almost nonexistent in the subbasin. Studies indicate that, for the basin as a whole, sizable unsatisfied demands for all species of fish will continue up to and beyond 2020. Clackamas River and tributaries have a considerable potential for meeting the needs for cold-water fish. It appears that there is a need for action to avoid loss of anadromous fish habitat and for measures to enhance the cold-water fish population and maintain or increase access thereto.

For Clackamas Subbasin, as in the whole basin, future supply of hunting opportunities is expected to be less than



Eagle Creek, a tributary of Clackamas River - popular fishing.

North Fork Dam on
Clackamas River.



demand. There will be a pressing need for wildlife habitat preservation and implementation of all practical wildlife enhancement programs. One such program is the acquisition and development of mineral springs to increase pigeon populations and improve hunting opportunities.

There is no flood control storage in the subbasin and operation of existing private power storage provides limited flood stage reductions. Existing small levee and channel stabilization projects provide protection only in specific small project areas. Based on present flooding conditions and resulting damages, there is an obvious need for both structural and nonstructural flood control measures. The prospect for economically justifiable storage development is not promising; further, the amount that could be developed would not provide an optimum degree of control. Levees and channel improvements supplemented by effective flood plain use regulation programs will be needed.

Although endowed with an abundant supply of water and a sizable area of potentially irrigable land, Clackamas Subbasin is not expected to realize any sub-

stantial expansion of irrigation development. The major deterrent will be a progressive reduction in the irrigable land base which lies adjacent to developing areas.

Municipal and industrial water supply needs which must be considered include those of the City of Estacada, the community of Boring, rural-domestic users, and the Portland service area, which includes



1964 Flood - Clackamas River east
of Oregon City.

the lower portion of the subbasin. Present sources for those areas outside of the service area are considered generally adequate, and relatively little additional storage will be required to meet needs during the early-action period.

The subbasin now has private power installations totaling more than 140,000 kilowatts, and has potentials for additional development. There exists a need for any justifiable power development.

The recreation needs being and to be served in Clackamas Subbasin include those of the subbasin plus adjoining areas, particularly the Portland metropolitan area. Development of the recreation resource has somewhat lagged behind the demand, especially in regard to facilities and access. There is a sizable total water-surface area in lakes, reservoirs, and on streams, yet there will be a need to develop additional areas to satisfy future demands. Primary recreation needs are for additional water-surface areas with appropriate facilities, and additional facilities and improved access on existing sites.

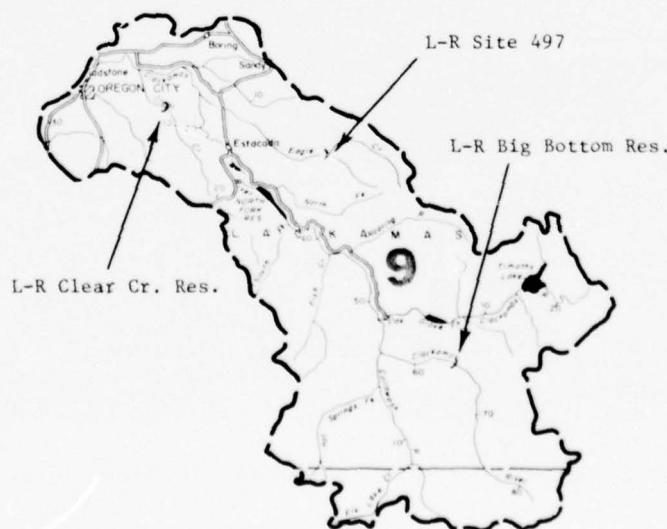
Clackamas River flows are generally well sustained and of acceptable quality. Waste loads on the stream are minor and storage to augment streamflows for water quality purposes does not appear warranted.

The Plan

The subbasin's primary assets are land, water, project sites, a still-desirable natural environment, and high recreation potential. The plan, presented following, includes smaller-scale elements during the early-action phase.

Early-Action Plan Elements.—No major project developments are proposed in the early-action phase for Clackamas Subbasin. Elements that should be undertaken include: (1) channel stabilization to prevent further bank deterioration; (2) additional recreation facilities; (3) acquisition of access and improvement of two mineral springs; (4) installation of irrigation facilities by private means and by the Molalla Project to be located mostly in the adjacent Pudding Subbasin; (5) a local program of flood plain use regulation to prevent further increases in flood damage potentials; (6) a management program for preservation of natural environment for Clackamas River, Collawash River, and Eagle Creek; (7) installation of one small group-enterprise job on agricultural land; and (8) soil and water restoration measures at 12 locations on O&C lands and 71 locations on National forest lands.

Long-Range Features.—Principal long-



range features include three potential multiple-purpose storage projects, one single-purpose hydroelectric power project, four pumped-storage facilities, and some additional channel modification for flood control.

Two reservoirs—Big Bottom, on Clackamas River, and Clear Creek, on a stream of the same name—would serve the functions of flood control, recreation, fish and wildlife, and municipal and industrial water supply. Storage capacities would be 120,000 and 60,000 acre-feet, respectively. Effects on fishery resources and natural environment would have to be given careful consideration.

Eagle Creek Reservoir, a watershed project, would be located in the upper reaches of Eagle Creek, a tributary of Clackamas River. It would have a capacity of 21,000 acre-feet and be used primarily for flood control purposes. Other uses would be identified specifically in future investigations.

Shellrock Hydroelectric Project, located on Oak Grove Fork Clackamas River,

would be a single-purpose power development. Water would be diverted from the river a few miles downstream from Timothy Lake and conveyed 4 to 5 miles in a pipeline to develop more than 900 feet of head and generate 35,000 kilowatts of electric power.

Four pumped-storage projects—Battle Creek, Cache Meadow, Cottonwood, and Squaw Meadow—would provide 18 million kilowatts of peaking-power capacity. Evaluation of the environmental impact of those facilities will be required because of their large size.

Other features would be primarily a continuation of the early-action programs and consist of channel modification; recreation facilities beyond those included with the storage projects; diversion, conveyance, and treatment facilities for municipal and industrial water; irrigation facilities; and waste treatment facilities. Initiative by Federal, State, and local governmental entities as well as private interests will be required to carry out these programs.



Timothy Lake on Oak Grove Fork Clackamas River.



Columbia Subbasin

The Setting

Metropolitan Portland sets the scene for Columbia Subbasin. The subbasin area of 431 square miles had a 1960 population of 562,000, or 1,300 persons per square mile. Approximately 47 percent of the area is devoted to business, industry, residential, and recreational uses. Some 23 percent of the land is in agricultural uses and another 30 percent is in forests. Projections indicate a 2020 population of about 1.8 million. Thus, there is little doubt that much of the subbasin will, within the foreseeable future, be in some stage of urbanization.

Portland is a world port connected to sea routes by a deep-draft channel in Columbia River. The economy is oriented toward trade, manufacturing of forest and agricultural products, finance and marketing, and the multitude of services connected with large metropolitan areas.

There are no major water resource developments in the subbasin. The most significant water-related needs are for flood control, fish and wildlife enhancement, water-based recreation, municipal and industrial water supplies for the Portland service area, and adequate water quality for year-round fish passage and use in the Portland harbor area.

All of the small streams in the subbasin are in need of additional low-water flow to enhance salmonoid production. In late summer, flows in the two largest tributary streams, Johnson and North Fork Scappoose Creeks, become almost non-existent. Moreover, much of the Johnson Creek low flow originates in Crystal Springs, near the mouth, and is not available to the stream system as a whole.



City of Portland dominates the subbasin.



Willamette River below the falls at Oregon City.

Summer water temperatures in lower portions of many streams and lakes in the subbasin approach or exceed critical levels for salmon and trout. Pollution commonly delays or prevents entry of anadromous fish into Scappoose and Milton Creeks. Further, water rights for consumptive use in the major fish-producing tributary stream systems total more than summer flows.

Water quality problems are experienced annually in Willamette River and the lower reaches of most tributaries. The Willamette River problem results principally from the fact that the greatly reduced velocity and increased travel time of flows passing through the enlarged tidal channel downstream from Willamette Falls permits the total waste loading to exert its full biochemical oxygen demand in the harbor reach. Even in consideration of anticipated adherence to Federally approved water standards, a 2020 need for flows up to 7,500 cubic feet per second exists in that reach to improve water quality so that anadromous fish passage can be assured.

Oregon State Game Commission owns extensive lands on Sauvie Island. Those

lands are being developed and managed for wildlife, particularly migratory waterfowl; public hunting and fishing; and recreation. In spite of that development, which is heavily used, hunting opportunities are not equal to demands. The primary needs are for acquisition and improvement of habitat and for hunter access.

Most of the Columbia-Willamette flood plain has been leveed, or is under consideration by the Corps of Engineers for levee construction. Upstream storage reservoirs in the Columbia River system, including Canadian storage under an International treaty, provide a considerable degree of protection against annual spring freshets on that stream. At present, annual flooding occurs on an area of more than 10,000 acres, mostly along Willamette River and Johnson Creek. There is a need for additional flood control for those areas and for channel improvement on several small tributaries.

Present irrigation requirements are relatively small in the subbasin. Because of its proximity to the rapidly expanding Portland metropolitan area, it is expected that by 2000 urban encroachment will have



By the year 2000, urban encroachment will have converted all of the sub-basin to nonagricultural use.

converted all of the potentially irrigable and irrigated lands to nonagricultural uses.

Municipal and industrial water sources for the small communities and rural areas are expected to be adequate and it is unlikely that additional sources will have to be developed to meet future demands. The Portland area, which extends into adjacent subbasins, will continue to have a high demand for water. Most of the present supply comes from Sandy Subbasin.

Development of water-related recreation facilities is one of the most pressing needs in the area. Private lands can satisfy a portion of the need. Much of the demand will be met by Willamette River. Full development of Columbia River, particularly its islands, is also needed. However, a deficit still will remain to be satisfied by other subbasins. Little opportunity for water-related recreation development exists on tributary streams in the subbasin.

The Plan

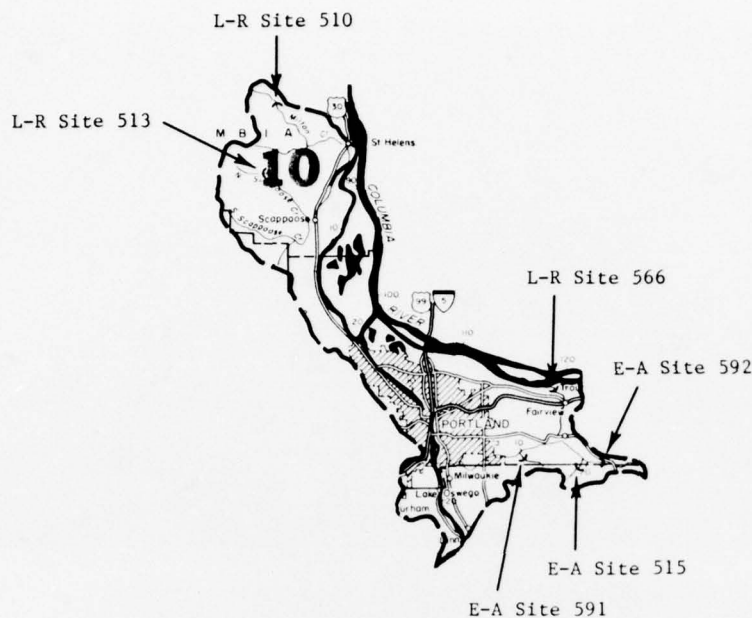
The expected large increase in population will create a variety of functional needs; however, opportunities for meeting

these needs within the subbasin are limited. Therefore, it appears that some needs such as those for municipal and industrial water supply and recreation must of necessity be met in part through developments in nearby subbasins.

Early-Action Plan Elements.—The early-action plan for Columbia Subbasin is primarily for reduction of flooding and related damages. Included are the authorized Johnson Creek flood control channel project, two watershed projects, and other miscellaneous features.

Johnson Creek Watershed Project would be compatible with the authorized Johnson Creek flood control channel project, or could function alone if that project were not constructed. The watershed project would include three reservoirs with combined storage capacity of about 5,400 acre-feet, and, in combination with the authorized channel project, would virtually eliminate flood damages on Johnson Creek. Water-based recreation, and possibly a reservoir fishery, would be associated with the reservoirs.

Fairview Creek Watershed Project would consist of about 3 miles of channel improvement and incorporation of appropriate land treatment practices. The



proposed project would reduce the average annual flood plain from about 90 acres to 10 acres and reduce flood damages in the watershed by 95 percent.

Other features included in the early-action plan are: (1) acquisition and development of a mineral spring near Scappoose, (2) acquisition of about 2,000 acres to be added to the Sauvie Island

Game Management Area for waterfowl habitat and shooting accommodations, (3) expanded private-sector and governmental recreation developments, particularly along Willamette and Columbia Rivers, (4) implementation of a zoning plan to control urbanization and industrialization of lands needed for outdoor recreation, (5) local regulation of flood plain use in the interest



Portland's deep draft harbor handles worldwide shipping.

of flood damage reduction, (6) four small group-enterprise jobs on agricultural lands, and (7) correction of soil and water restoration problems at two locations on O&C forest lands.

Long-Range Features.—Long-range features include multiple-purpose storage in three watershed projects, facilities for municipal and industrial water treatment and conveyance, waste treatment facilities, land treatment, and recreation facilities.

Watershed projects are planned for Milton and Scappoose Creeks and the early-action project on Fairview Creek would be expanded. Principal structural measures involved would be an 18,200-acre-foot reservoir on upper Scappoose Creek, a 10,000-acre-foot reservoir on Milton Creek, a 1,740-acre-foot reservoir on Fairview Creek, and about 5 miles of tributary channel improvements.



Sandy Subbasin

The Setting

Mt. Hood dominates Sandy Subbasin, a 582-square-mile area which is 90 percent forested. The Sandy Subbasin drainage, like the Clackamas, provides an environmental and recreational release valve for urban and suburban Portland. The area is rugged and only about half is accessible by car. Mt. Hood, with its glaciers and snow fields, and the western Cascades provide for extensive scenic and recreational use both summer and winter. Nearly all forms of outdoor sports activity are available including hiking, camping, fishing, hunting, skiing,

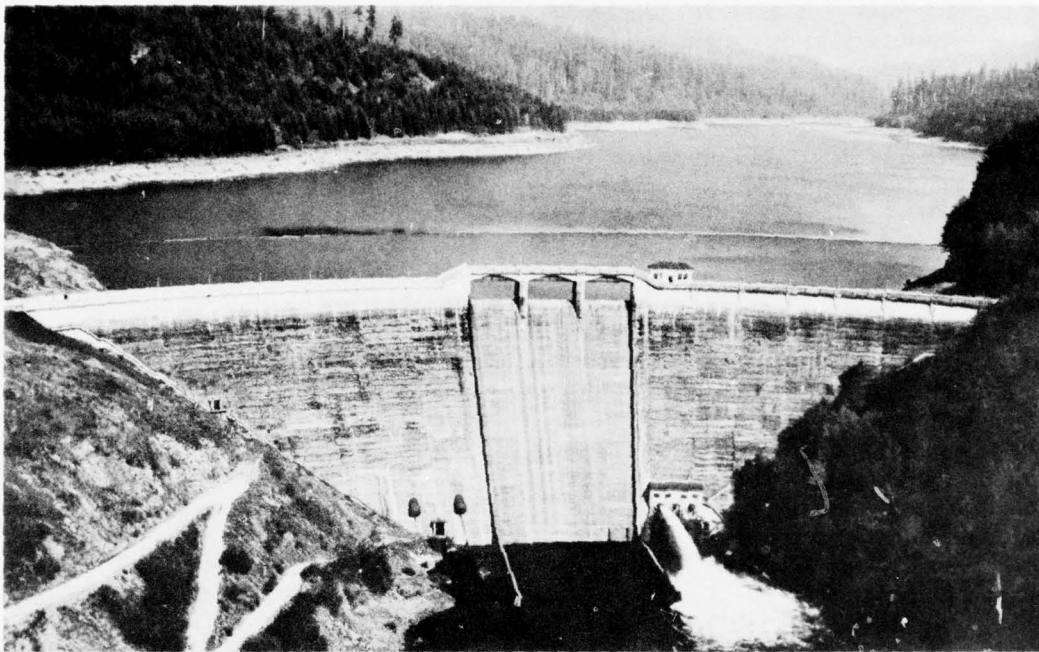
mountain climbing, nature study, and scenic enjoyment.

Population in 1960 was 9,700, with an average density of 17 persons per square mile. Projections indicate that by 2020 there still will be only about 23,000 people living in Sandy Subbasin. However, the number of people using the area will be quite large. Much of that use will be of a recreational and environmental nature.

Sandy Subbasin is made up primarily of the Sandy River drainage area. It is the only subbasin in the study area from which runoff does not drain directly into Willamette River or Willamette Slough. Sandy River flows directly into Columbia River near Troutdale. Main tributaries of the Sandy, all with headwaters in the Cascade Range, include Bull Run, Upper Sandy, Zigzag, and Salmon Rivers. Also, several small subbasin streams flow directly into Columbia River.

Existing water resource development in the subbasin consists of six storage impoundments: four for municipal water supply, one for power generation, and one recreation development. All of the existing development has been accomplished by non-Federal entities.

Existing streamflows are sufficient in most cases to meet recommended minimum fish flows. Optimum fish flows are met on Sandy River except in the reach from Marmot Dam downstream to Bull Run River. Diversions at Marmot Dam, for power generation, often reduce flows, between the diversion and the downstream point of return at the mouth of Bull Run River, to less than minimum for fish life. Water temperatures in the streams, other than lower Sandy River, seldom exceed 65°F. Barriers to fish passage include Marmot Dam on Sandy River, Little Sandy Dam on Little Sandy River, Bull Run Dams Nos. 1 and 2 on Bull Run River, and several falls. There are several possibilities for resolving the barrier problems, including trapping and hauling around the barriers, and laddering; however, no action has been taken. Another fish-passage problem involves the severe daily fluctuation in flow



Lake Ben Morrow on Bull Run River - water storage for Portland.

of Sandy River because of power peaking operations on Bull Run River. To meet the demands for resident trout fisheries will require additional stocking and water-surface area, and improved access to the Cascade Lakes.

Basin-wide supplies of many species of wildlife are insufficient and, for some, demands cannot be satisfied in the future. A significant exception is fur animals, for which the supply is greater than the limited demand.

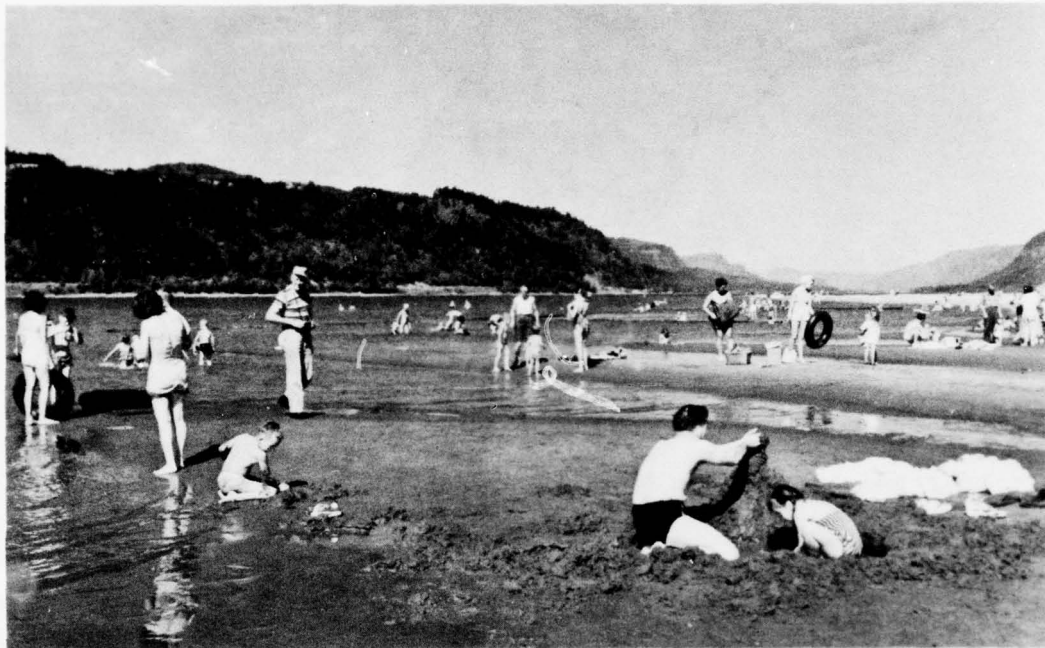
There are no existing or authorized storage or local flood control projects and flooding occurs annually on about 2,600 acres. Because there are no promising storage sites in the downstream reaches of Sandy River, it is probable that locally accomplished flood-plain-use regulation will provide the only effective control over future increases in flood damages. Needs for channel stabilization have been identified for about 4 miles on Sandy River.

There are no irrigation projects in Sandy Subbasin and the potential for irrigation is limited. All surface waters of the subbasin,

except the tributaries to lower Sandy River, have been withdrawn from further irrigation appropriation. Any further irrigation development would be expected to depend on the use of ground water, storage in farm ponds, or pumping from Columbia River.

Bull Run Watershed, within Sandy Subbasin, is the largest single source of municipal supply for the Portland service area. The City has been granted exclusive right to the use of waters from Bull Run and Little Sandy Rivers by State water laws (ORS 538.420). Restrictions on use of the Federal lands involved are covered by the Act of March 4, 1909 (35 Stat. 1099). The existing Bull Run storage, plus planned expansion, will be adequate until sometime beyond 2000. After that, additional municipal and industrial water needs for the Portland service area would have to be developed from sources outside of Sandy Subbasin. Water supplies for the towns and communities within the subbasin appear generally adequate through 2020.

Existing recreation facilities are ade-



Rooster Rock State Park on Columbia River.

quate to meet the present demand; however, projected demands indicate there will be a need for nearly twice the facility capacity by 2020. Existing water-surface area, within the subbasin, if totally available for public use, could satisfy about two-thirds of the 1980 demand. Without additional water-surface area, less than 40 percent of the recreation demand could be met in 2020. To satisfy the growing recreation demand, in terms of opportunities and facilities, would require participation on a broad scale from private-sector to multiagency project-type development.

There are no existing severe water quality or pollution problems in the subbasin, nor are any expected in the future.

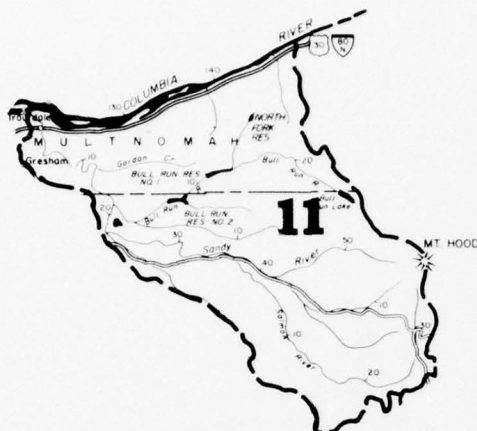
The Plan

A review of the water and related land resource needs in Sandy Subbasin shows that the principal water-related needs are for flood control, recreation, fish and wildlife enhancement, and municipal and

industrial water supplies. In view of the few storage development opportunities, it appears that effective programs and non-storage projects offer the best opportunity to meet the water-related needs in the subbasin.

Early-Action Plan Elements.—Measures for early action in the subbasin are directed to meeting flood control, municipal and industrial water, irrigation, and recreation needs. The plan provides for retention of much of the subbasin's recreation potential, desirable because of the nearness of the Portland Metropolitan area. Unstable reaches totaling about 1-1/3 miles on Sandy River should receive channel stabilization works by 1980. That work should be coordinated with recreation and fish and wildlife interests.

A program of flood plain use regulation and zoning along Sandy River should be implemented by a local government. The program should provide for retention of the rugged natural beauty of the river for recreational use, as well as for flood dam-



age reduction in the future.

Additional municipal and industrial water supplies will be required during the early-action period by the City of Portland. The City has plans to increase storage in the Bull Run watershed by about 34,000 acre-feet (11,000 mg) by 1985. The possibility of opening Bull Run watershed to public use, particularly for recreation, fishing and hunting, is being investigated by the U. S. Forest Service, the City of Portland and other interested agencies.

Other elements named for early-action implementation include recreation facilities—water and nonwater related; fish passage facilities at the principal stream barriers; improved access to fishing and recreation sites, as well as studies to analyze the recreational significance of the Barlow Road and Columbia Gorge; irrigation facilities to serve the projected increase in irrigated land, the bulk of which

would be developed and provided by the private sector; soil and water restoration measures at 3 locations on O&C lands and 21 locations on National forest lands; and environmental management of Sandy River.

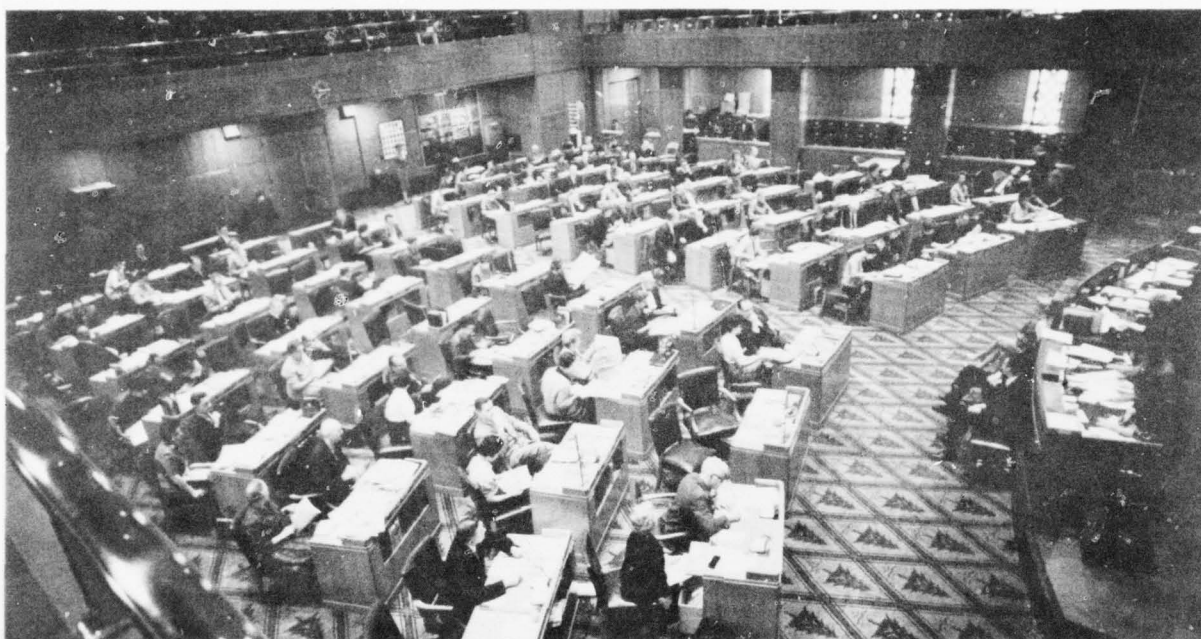
Long-Range Features.—Elements proposed for long-range action consist of followup and continuation of measures recommended for early action. Additional storage will be needed during the long-range period to supplement Portland's municipal and industrial water supplies in the Bull Run watershed. Other elements should include additional channel stabilization on Sandy River; continued efforts toward enhancement of fish and wildlife resources; Federal and non-Federal participation in developing recreation areas and facilities; and private sector development of irrigation facilities.



Mt. Hood - highest peak in the basin and in Oregon.

Willamette River 10 miles north of Eugene.







PUTTING THE PLAN INTO ACTION

Willamette Basin now is, and must remain, a desirable place for people to live, work, and play. The plan as presented herein was formulated to fulfill this basic concept. It is well adapted to control, use, and development of the basin's water and related land resources, and at the same time includes preservation of the most desirable natural environmental features. It provides service across the full range of presently recognized functional uses and is flexible both as to timing and to choice of elements.

Principal steps required to put the plan into action are:

1. Approval of the plan by the Pacific Northwest River Basins Commission, the Water Resources Council, and the State of Oregon.
2. Completion of necessary additional studies. Federal, State and local participation will be required.
3. Congressional authorization of those projects and programs involving Federal responsibility.
4. Congressional appropriation of funds for planning and construction of projects and for implementation of programs.
5. Continued coordination among governmental entities and the general public leading to development by appropriate agencies or the private sector.

Making the plan an effective guide for

development within Willamette Basin will require the combined efforts of Federal agencies, the State of Oregon, local governments, and the private sector. The State of Oregon and local interests have the responsibility for getting many of the projects and programs of the plan underway. While Federal agencies may do most of the detailed planning and construction, the people who will directly benefit must provide the basic initiative. The early-action projects and programs which would be undertaken by the Federal agencies will be presented to Congress for approval and funding through the established procedures. The state and local agencies will be responsible for implementation of their programs and construction of improvements. Where applicable these responsibilities will be shared with other state and Federal agencies.

Steps to implement certain activities should be undertaken as soon as the basin plan has been adopted. These activities include: (1) the environmental management program, (2) those program activities which involve acquisition of lands for the public benefit, (3) streamflow-forecasting and related programs, (4) the air-pollution support program, and (5) those study and research activities related to future planning and decision making.

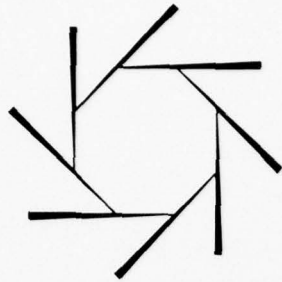
Continuing requirements will be to provide for completion of ongoing agency studies and for periodic review and updating of the comprehensive basin plan. Such planning should be carried on by the agencies in cooperation with the Pacific Northwest River Basins Commission and the Water Resources Council.

*Quality of the environment, like freedom, must be protected
and achieved anew by each generation.*

Laurance S. Rockefeller

Santiam River mirrors the bridge at Jefferson during low flows.





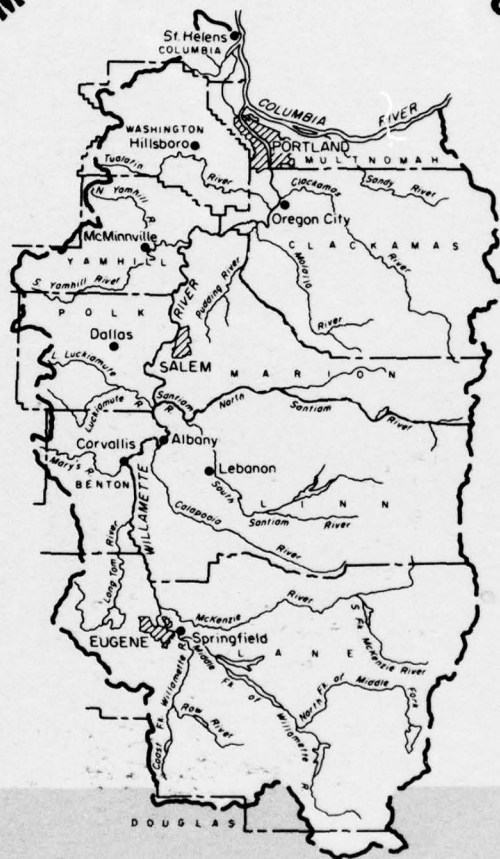
S U M M A R Y

R E C O M M E N D A T I O N S

The Willamette Basin Task Force recommends the adoption of the comprehensive basin plan as a guide for the development, conservation, and preservation of water and related land resources within Willamette Basin. It further recommends that:

1. Steps be taken immediately to implement the early-action proposals.
2. Subsequent formulation studies of individual plan elements give full consideration to maximizing multiple-purpose aspects of each project. This would include, particularly, those aspects related to overall environment and quality of life.
3. All program elements of the plan be continued, accelerated, or initiated as appropriate.
4. Consideration be given at both State and Federal levels to analyzing and resolving legal and institutional problems. Those actions must be accomplished as soon as possible if the viability of the plan presented herein is to be preserved.
5. Consideration be given to timely completion of ongoing agency studies and to planning for future review and updating of the comprehensive basin plan. Such planning should be initiated immediately in cooperation and coordination with the State of Oregon, the Pacific Northwest River Basins Commission, and the Water Resources Council.

COMPREHENSIVE STUDY



Willamette Basin